Southwest FISHERIES CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES July-August 1988

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COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

CalCOFI Reports Now Listed in International Bibliographic Indices

Gail Theilacker, CalCOFI Coordinator, relates that all page- proofs of manuscripts for Volume 29 of the CalCOFI Reports have been sent to the Editor, and the issue should be printed in time to be distributed at the November CalCOFI Conference. In regard to the Reports, she is pleased to note that Cambridge Scientific Abstracts will abstract CalCOFI Reports in Aquatic Sciences and Fisheries Abstracts (ASFA) and Oceanic Abstracts beginning with Volume 27, 1986. Additionally, the Institute for Scientific Information has agreed to include CalCOFI Reports in the Science Citation Index (SCI), Automatic Subject Citation Alert (ASCA), Current Contents/Agriculture, Biology & Environmental Sciences and on the online database SCISEARCH.

Plans have begun for the November Conference at Lake Arrowhead; the second announcement mailed last week listed the contributed oral and poster presentations. This year's Symposium, "Can Marine Fisheries Be Enhanced?" will be convened by John Grant, California Department of Fish and Game (CDF&G). The Point/Counterpoint format will cover habitat manipulation, artificial propagation, harvest refugia and enhancement opportunities. (G. Theilacker, FTS 893-7125)

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Acoustic Doppler Current Profiler Adapted to CalCOFI Survey

Dr. Paul Smith has used the acoustic doppler current profiler (ADCP) to detect the scale and intensity of pattern in volume reverberation as a function of distance offshore and depth. Biological scattering at 150 kilo-Herz (kHz) has been recorded for the 48,000 square nautical mile pattern of the CalCOFI cruises. Figure 1 shows the beam configuration of the ADCP. In Figure 2 is a display of the volume reverberation in standard deviation units (normalized at each depth) as a function of depth and distance offshore. High values indicate high concentrations of zooplankton and fish. In Figure 3 are shown the zooplankton volumes taken at the same positions as the ADCP data: there appears to be a rough congruence in cross-shelf trends highlighting the passage across the

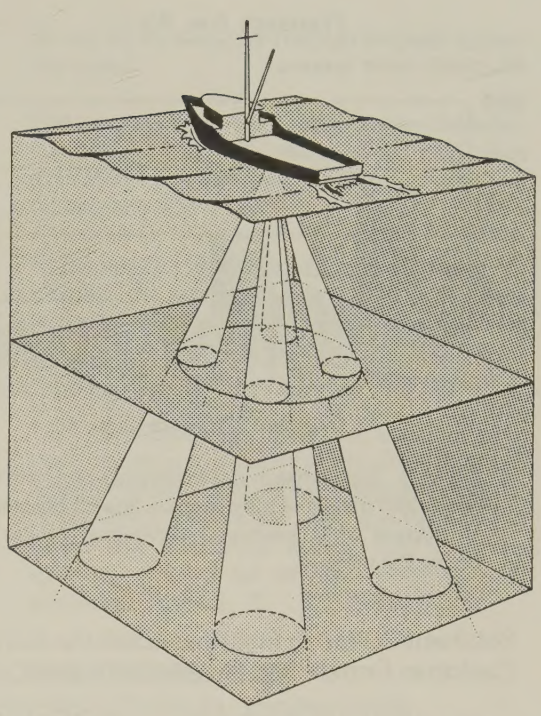

Figure 1. Diagram of the position and orientation of the 4 transducers of the acoustic doppler current profiler (ADCP) used on the *New Horizon* CalCOFI cruise of August 1988.

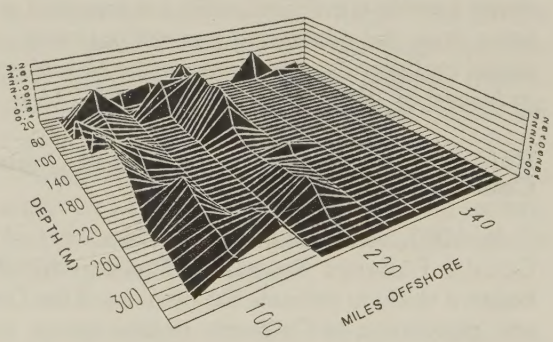

Figure 2. Three dimensional surface representation of the distribution of acoustic volume reverberation along CalCOFI line 93 which intercepts the coastline at Del Mar and proceeds at a direction of 240°, as a function of depth and distance off the coast. Each depth line is 8 meters. The amplitude of the reverberation is expressed in normal units (standard deviations above the mean). The vertical lines begin within 15 miles of the coast and are at 40 mile intervals. These lines coincide in time with the standard CalCOFI bongo tow.

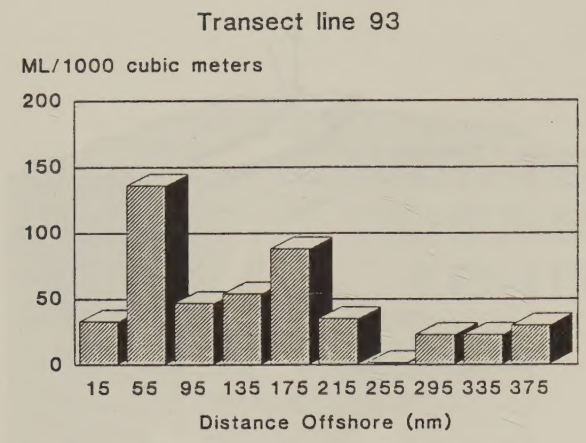

Figure 3. Zooplankton displacement volume in the upper 200 meters of the ocean on line 93 expressed as normal units (standard deviations above or below the mean).

Southern California Bight and across the axis of the California Current into the offshore waters.

This process is being developed to record changes in depth of biological patches and layers and the distance offshore of the concentrations of biomass. It is expected that the El Niño phenomenon will affect both features of the California Current and the nearshore region. While the depth-specific current velocities are recorded at the same time, the processing has not yet been completed for the cruise which was on the *New Horizon* in August of 1988. (P. Smith, FTS 893-7169)

Rate of Spawning of Dover Sole in Central California

In 1987, Mathematician Dr. Nancy Lo of the Coastal Fisheries Resources Division (CFRD), began a study to estimate the biomass of the Dover sole population in California coastal waters using egg production and swept trawl methodologies. Two surveys of central California waters (8701, 8803) have been completed. The survey extended from Pt. Conception to Monterey Bay (Figure 1). Adult Dover sole and their planktonic eggs were collected and used to estimate reproductive output rates which will ultimately be used to estimate the spawning biomass. In this report Dr. Lo presents the preliminary estimates of the reproductive parameters of adult Dover sole, including average female weight in grams (W), female fraction of the population by weight (R), weight specific total fecundity in number of yolked eggs (F), fraction of females with active ovaries (active females) (S), and the daily specific fecundity (eggs/mton-day). In addition to the two surveys mentioned above, Lo used

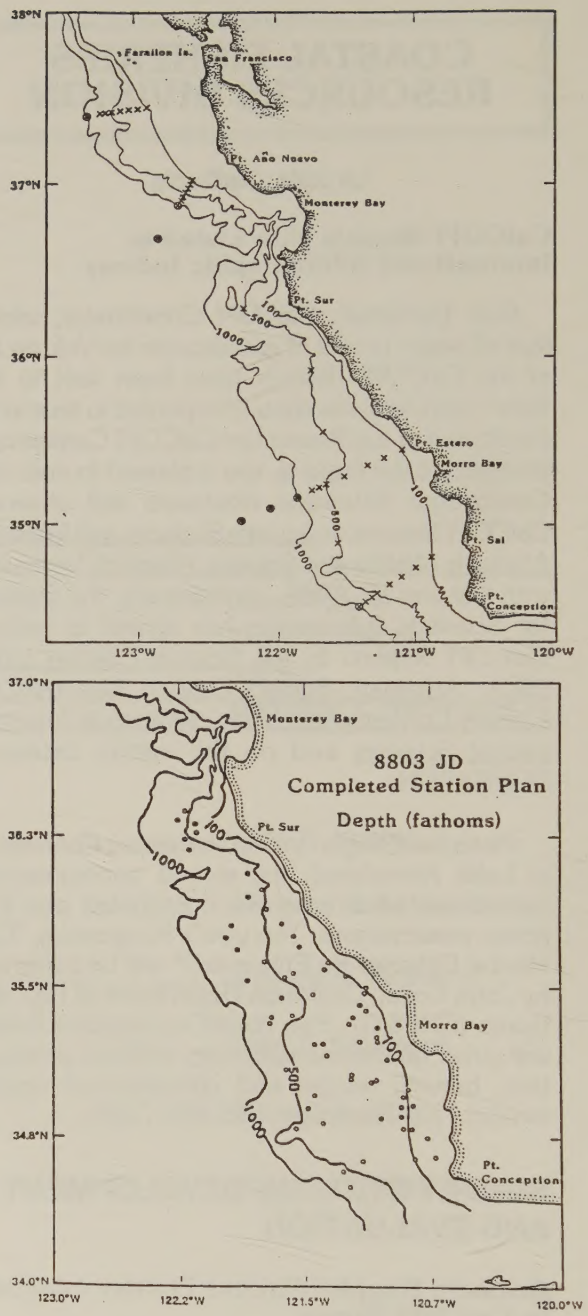

Figure 1. Survey area of Dover sole cruises 8701 (January 8- February 17) (top) and 8803 (February 22-April 10) (bottom). The survey pattern for 8701 is line transact sampling and for 8803 is random sampling.

some incidental collections of Dover sole taken in 1985 and 1986 (8512, 8604, and 8606).

The survey area was stratified by depth: stratum 1 (<=249 fm, 455 m), stratum 2 (250-549 fm, 457-1004 m) and stratum 3 (>=550 fm, 1006 m). Most of the mature fish were found

in strata 2 and 3. When the sample size within stratum was small, the data were pooled over all depth strata and years. The five reproductive parameters estimated by Lo for Dover sole are described below.

1. The average female weight (W). A strong correlation existed between fish weight and depth. For 1985-88, the average female fish weight was 229.1 gm (0.5 lb) (SD=138.9 gm, n=37) for stratum 1, 770.2 gm (1.7 lbs) (SD=186.7gm, n=62) for stratum 2, and 1056.7 gm (2.33 lbs) (SD=287.8 gm, n=19) for stratum 3. The unstratified average female fish weight was 646.7 gm (1.43 lbs) (SE=356.9 gm lb, n=118).

2. Female fraction of the population by weight (R). The female fraction of the catch was computed for each depth stratum. The estimates are 0.70 for stratum 1, 0.66 for stratum 2, and 1.0 for stratum 3. The unstratified weighted average is 0.67.

3. Total fecundity (F). The total fecundity is the total number of yolked eggs present in the ovary; it is a function of female fish weight and decreases as the season progresses. A linear regression was used to model the fecundity (F) with fish weight (W, in gm) and Julian day (d; d=1 for Jan 1, d=2 for Jan 2, ...):

F= 26221 + 37.75*W - 229.96*d

4. The fraction of females with active ovaries(S). This parameter is the fraction of females taken during a survey that had reproductively active ovaries (yolked oocytes) present. This fraction increased with female fish weight and decreased with Julian day. An exponential function was used to model the relationship between the fraction of active female(S) and two variables: fish weight (W, in gm) and Julian day (d). A weighted nonlinear regression procedure was used to estimate the parameters:

S= 0.15*exp(0.0018*W - 0.0097*d)

5. The daily fecundity per female (F*S/d). To estimate the daily fecundity per female, the total fecundity (number of yolked eggs) (F) and fraction of active females (S) are measured throughout the survey (spawning) period. Because the quantities of both parameters decrease as the season progresses, for a given time interval between two Julian days, d1 and d2, the daily fecundity per female (F*S/d) can be estimated as:

(F1*S1 - F2*S2)/(d2 - d1)

Where F1 = #eggs/active female in d1,
S1 = fraction of active female in d1,
F2 and S2 are defined similar to F1 and S1,
d1 and d2 are two Julian days in the peak spawning season.

The values of F*S/d vary depending on the selection of d1 and d2. The estimates of F*S/d range from 107 to 280 with the midpoint 171 for d1 and d2 between 0 and 100.

6. The specific daily fecundity, eggs/mton-day. To estimate the spawning rate (the specific daily fecundity) of Dover sole, we used the unstratified average for each parameter estimate defined above. The specific daily fecundity is computed as (R/W)*(F*S/d) = (0.67/646.7 gm)*171 =0.18 $*10^6$ eggs/mton-day. This rate is much lower than northern anchovy which is $37*10^6$ eggs/mton-day (Administrative Report LJ-85-21, A. Bindman). Thus, the daily spawning rate of Dover sole population is only 1/200th of the spawning rate of an anchovy population of equivalent biomass. (N. Lo, FTS 893-7123)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Annual Status of Coastal Pelagic Fishery Report

Cynthia Thomson, Industry Economist, co-authored an Administrative Report (LJ-88-18) with Cheryl Scannell (California Department of Fish and Game) and James Morgan (NMFS Southwest Region) entitled "Status of the California Coastal Pelagic Fisheries in 1987." The report describes management programs, the commercial harvesting and processing sectors, and the recreational fisheries as they relate to the coastal pelagic species.

Total landings and real revenues increased by 6% and 7% respectively between 1986 and 1987--largely due to the increased availability of bonito. Squid landings dropped only slightly from the 1986 level, maintaining the dramatic recovery that occurred in that year. Mackerel (Pacific and jack) accounted for 66% of total landings and 53% of total revenue generated in 1987 from the coastal pelagic species. Continuing the trend of the previous four years, anchovy were landed in very modest numbers and used largely for non-reduction purposes. Over 80% of the sardines landed in 1987 were taken incidentally with mackerel; most of the remainder was used as cut bait in the inland striped bass fishery.

California commercial landings and ex-vessel revenues for 1982-1987 can be summarized as follows:

Year	Landings (metric tons) Anchovy	Mackerel	Bonito	Squid	Sardine	Total
1982	42,050	52,983	2,325	16,240	132	113,730
1983	4,300	50,682	3,404	1,816	352	60,554
1984	2,905	52,709	2,802	564	238	59,218
1985	2,009	43,090	2,367	9,308	592	57,366
1986	1,548	52,878	240	21,280	1,188	77,134
1987	1,303	53,475	5,048	19,575	2,095	81,496

Year[1]	Ex-Vessel Revenues ($1000's) Anchovy	Mackerel	Bonito	Squid	Sardine	Total	Total
1982	2,124	10,480	1,087	3,590	26	17,307	17,307
1983	394	9,633	1,373	754	67	12,220	11,768
1984	665	9,531	832	305	43	11,376	10,558
1985	417	7,983	504	3,731	110	12,745	11,464
1986	274	8,590	83	4,882	215	14,044	12,265
1987	239	8,090	2,401	4,340	315	15,385	13,984

[1]Deflated by GNP Implicit Price Deflator (Base Year=1982).

Approximately 4,461 metric tons of live bait of all species were caught in 1987. This figure includes both logged and estimated unlogged catches. The live bait catch consisted largely of northern anchovy but also included smaller but significant amounts of sardine and squid. Anchovy catches were relatively low in 1987, due to poor availability in nearshore areas and to poor albacore fishing in July-August of that year.

Management of northern anchovy and Pacific mackerel is based on a July 1-June 30 fishing season, while management of Pacific sardine takes place on a calendar year basis. The anchovy reduction quota in the U.S. Fishery Conservation Zone has been set at 140,000 metric tons for the 1988-89 season; this is the maximum amount allowed by the Northern Anchovy Fishery Management Plan. No limit has been placed on Pacific mackerel landings in 1988-89. The third annual 907 metric ton sardine directed fishery was opened on January 1, 1988, and the quota was exhausted by January 15. Most of the sardine landings were canned in brine and test marketed for domestic human consumption.

Judging from mackerel, bonito and squid landings to date, total 1988 landings of these species are likely to equal or exceed their 1987 levels. The upward movement in the fishmeal market price in 1987 has continued into 1988. Whether the higher fishmeal price will translate into a sufficiently high ex-vessel price to motivate participation in the anchovy reduction fishery is unknown at this time. (C. Thomson, FTS 893-7115)

California Entangling Net Fisheries Reviewed

SWFC Industry Economist Sam Herrick and Biologist Doyle Hanan of the California Department of Fish and Game, are the authors of a recently published NOAA Technical Memorandum entitled "A review of California entangling net fisheries, 1981-1986."

During the late 1970's and early 1980's the use of entangling nets in coastal California waters to harvest a number of oceanic and nearshore species expanded rapidly. However, development of the California entangling net fisheries has met with stiff opposition and public pressure from wide-ranging marine resource interest groups seeking limits or a complete ban on the use of entangling nets. Issues dealing with interactions between other commercial and recreational fisheries, as well as conservation and threats to protected species have become hotly debated.

In response to the issues raised over the use of entangling nets, the state of California has established a number of regulations that directly

affect entangling gear fisheries in its coastal waters. These regulations pertain to the configuration and deployment of the gear itself as well as to the number of fisherman who can legally fish entangling nets. Additionally, entangling net fisheries off California are indirectly affected by the federally enacted Marine Mammal Protection Act of 1972 (16 U.S.C. ss 1513, et seq.) which imposes a moratorium on the taking of marine mammals except by federal permit, and the Migratory Bird Treaty Act (16 U.S.C. ss 703-711) which prohibits the taking or killing of migratory birds by any means unless authorized by regulation.

In their paper, Herrick and Hanan provide background information on the operations and state management of the major entanglement net fisheries occurring off California. They review the size and composition of landings by entangling nets in California from 1981 through 1986, emphasizing the magnitude and diversity of entangling landings vis a vis landings by other commercial and recreational fisheries. The incidence of marine mammal mortality due to entangling net fishing operations is also investigated. Special attention is given to vessels that participate in the drift gill net fishery with regard to their alternative fisheries activities and opportunities.

The authors find that while numerous commercial species are reported in the entangling net landings, relatively few of these are important in terms of overall volume. Moreover, when landings compositions from the different entangling net fisheries are examined, distinct patterns emerge suggesting that the different types of entangling nets can be quite selective with regard to the species landed. Except for halibut and swordfish, there appears to be very little direct competition between entangling nets, and other commercial fisheries for the species in the major market categories. Halibut is also a popular recreational species as are white sea bass, rockfish and white croaker - other species comprising entangling net landings. Marlin, chinook and coho salmon, striped bass, and kelp bass are other important recreational species that have been observed in entangling net catches.

The other area of concern addressed by Herrick and Hanan has to do with the accidental take of marine mammals and sea birds in entangling net fisheries. They show that this problem has been most severe in the set net fisheries off the central California coast, but is present in all entangling net fisheries. Although a great number of regulations have been implemented on a fishery by fishery basis to deal with specific instances of accidental take, the authors point out that finding solutions to the marine mammal-seabird mortality problem is a difficult ongoing process. Several pieces of state legislation are pending, and the federal Marine Mammal Protection Act is coming up for reauthorization.

The authors suggest that the potential impact of more stringent regulations on the use of entangling nets is liable to be mitigated by the ability of affected vessels to engage in alternative fisheries. This is suggested by the fact that drift gill net vessels typically land two or more species during the course of the year, and they typically use at least two different gears in their fishing operations. Some of the species/gear combinations have overlapping seasons. This flexibility not only eases the burden of a greater regulatory load, but enables vessels that participate in entangling net fisheries to more readily respond to changing biological, environmental, and economic conditions. (S. Herrick, Jr., FTS 893-7111)

Relationship of Fishing Capacity to Vessel Size

The Pacific Fishery Management Council is in the process of developing a license limitation system for the Pacific coast commercial groundfish industry. Even with license limitation, however, a commercial fishing fleet can expand its fishing capacity through vessel and gear upgrading; this can prevent the program from achieving its objective of reducing fishing capacity and increasing fleet profitability. Thus the Council needs a means of rating the capacities of vessels, so that it can regulate the upgrading and consolidation of licenses. To address this issue for the proposed groundfish limited entry program, Dr. Dale Squires, Industry Economist in La Jolla, is examining measures of fishing power which would be appropriate for controlling vessel capacity.

Constraining vessel capacity raises the issue of identifying the most appropriate method of predicting the catch of individual vessels. Overall vessel length has initially been identified as the most documentable measure of vessel harvesting capacity. Yet concern has been expressed over the suitability of overall length as a

Table 1. Summaries results of regression analysis of fishing power. Each entry is R^2 as measure of model fit.

Combinations of independ. vars	Groundfish trawl	Longline	Shrimp	Fish pot
Len	0.44	0.09	0.11	0.06
Len, Ntrips	0.45	0.24	0.34	0.18
Len, Len Sq, Ntrips, Ntrips Sq	0.54	0.34	0.38	0.88
Len, Len Sq, Age, Ntrips, Ntrips Sq	0.55	0.42	0.44	0.70
Len, Len Sq, Ntrips, Ntrips Sq, Len*Ntrips	0.60	0.39	0.64	0.92
Ton	0.49	0.07	0.13	0.09
Ton, Ntrips	0.49	0.22	0.37	0.16
Ton, Ton Sq, Ntrips, Ntrips Sq	0.61	0.40	0.43	0.77
Ton, Ton Sq, Age, Ntrips, Ntrips Sq	0.62	0.43	0.45	0.84
Ton, Ton Sq, Ntrips, Ntrips Sq, Ton*Ntrips	0.68	0.54	0.69	0.87

NOTE: Ordinary least squares regression with total annual catch in pounds as dependent variable, and independent variables being a constant intercept and various combinations of explanatory variables. Len refers to overall vessel length in feet; Ntrips refers number of trips per year per vessel; Ton refers to vessel registered tons; Len*Ntrips refers to the interaction between length and number of trips; Ton*Ntrips refers to the interaction between registered tonnage and number of trips.

measure of vessel capacity. In turn, this concern raises the possibility of finding alternative documentable measures. Other documentable vessel attributes include vessel registered tonnage, year built, and gear types used on a trip.

Regression analysis of 1986 vessel-level data was used to assess the suitability of vessel length, registered vessel tonnage, year built, and gear employed as candidate measures of fishing capacity. All 1986 trips were classified as groundfish trawl, shrimp trawl, long line, or fish pot. Both trip-level and annual data were available. Data were from the PacFIN Research Data Base. For each gear group, total catch per vessel per trip was regressed using ordinary least squares upon an intercept term and either length or registered tons as the major contributor to total catch. Vessel age was sometimes included. Some regression runs included both length and length squared or registered tonnage and registered tonnage squared. Regression runs using aggregate data also included the number of trips per year. While only regression runs using annual data are discussed here, regressions were also run using trip-level data and quarterly dummy variables for spring, summer, and fall and area dummy variables for the Vancouver and Columbia INPFC areas. A linear functional form was specified for all regressions.

Model performance, percent of variation in data explained, indicated uneven performance according to gear type. Generally less than 60% of all variation was explained, with R^2's typically ranging from 0.05 to 0.55. Fish pot vessels offered the major exception, with R^2's up to 0.92. The explanatory variables were usually statistically significant at 5%. The simplest models with just an intercept term and either length or registered tonnage generally did a poor job of explaining the variation in the data. Model performance improved when more than just the single vessel attribute of either or length or registered tonnage was included. These results affirm prior belief that fishing capacity is complex and multidimensional, not easily captured by a single vessel attribute and that nonlinear relationships are likely to be involved.

It is readily apparent that all of the models provided inaccurate predictions of expected annual total catch, regardless of the combinations of vessel length, registered tonnage, or age which were specified as the primary variables contributing to vessel capacity.

What conclusions can be derived from these results? These results cast into doubt the ability to successfully constrain vessel capacity by merely limiting a single, easily documented vessel attribute such as length or registered tonnage when

the components of fishing capacity are multidimensional and complex. (D. Squires, FTS 893-7113)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

FISHERY INDEPENDENT ASSESSMENT PROGRAM

Third Annual Survey to Monitor Trends in Dolphin Abundance Begins

On July 28, two NOAA research vessels, the *David Starr Jordan* and the *McArthur*, departed San Diego to participate on a 4 month survey censusing dolphins and their habitat in the eastern tropical Pacific (ETP) Ocean. The Southwest Fisheries Center (SWFC) is responsible for monitoring the status of stocks of dolphins which are incidentally killed during tuna purse seining activities in the ETP. This year is the third in a series of six research vessel surveys to monitor trends in abundance of dolphin stocks.

The first leg of this year's survey was completed, as scheduled, on August 25. The *Jordan* entered port at Puerto Quetzal, San Jose, Guatemala, after surveying out to 126°W and as far south as 1°N (Leg 4 for *Jordan*, Figure 1). The *Jordan* was originally scheduled to survey in coastal and near-coastal waters between San Diego and Guatemala (Leg 1 for *Jordan*, Figure 1); however, research clearance from Mexico was not received prior to the *Jordan's* departure from San Diego. Assuming clearance is received by the fourth leg of the survey (beginning November 7), the areas missed by the *Jordan* during the first leg will be covered during the fourth leg. This will not have a detrimental affect on the trend analyses (data are clumped over legs); however, the oceanographic studies which are time-area dependent will be impacted. The *McArthur* surveyed between San Diego and Hilo, Hawaii (Leg 1 for *McArthur*, Figure 1), where it entered port for fuel and supplies. Both vessels will depart on the second leg of this year's survey on August 31. The next inport for both vessels is scheduled for September 29 through October 4 at Rodman, Panama. At that time, SWFC scientific personnel will switch vessels.

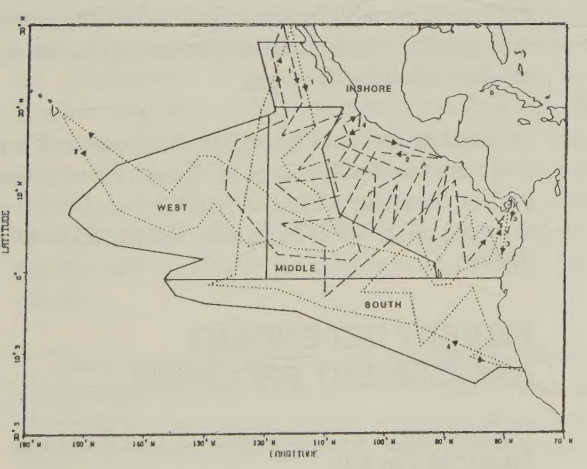

Figure 1. Scheduled tracklines for NOAA Ships *David Starr Jordan* (dashed line) and *McArthur* (dotted line) for July 28 through December 7, 1988.

During the first leg, sighting information has been collected for 35 spotted and/or spinner dolphin schools and 48 schools of common, striped or Fraser's dolphins (the primary target species of the fishery). Information was also collected for 105 additional cetacean sightings. Observers on both vessels collected information describing birds and turtles encountered throughout the survey area. Manta tows and dipnetting (for flying fish) were conducted nightly on both vessels. Specimens collected are being stored in freezers aboard the vessels until their return to San Diego in December. Environmental and oceanographic data collection procedures continued throughout the leg on both vessels.

XBTs were deployed (four/day) and CTD stations (1/day unless otherwise requested) were conducted daily as weather permitted. The Atlantic Oceanographic and Meterological Laboratory was responsible for the majority of the oceanographic data collection aboard the *Jordan*. The *McArthur*, at the request of the Pacific Marine Environmental Laboratory (PMEL), investigated the status of a malfunctioning Atlas buoy located at 5°N and 110°W. PMEL has requested an additional stop at this buoy during the second leg; new parts sent to the vessel during their inport in Hawaii will be used to repair the buoy. Adverse weather conditions prohibited data collection for a total of 8 days for both vessels.

The Photogrammetric Remote Sensing Group (PRSG) at the SWFC operates aboard the *David Starr Jordan* using a Hughes 500D helicopter. The primary responsibility of the PRSG is to photograph dolphin schools and use the photographs to calibrate observers' school size estimates. School size estimates are a critical component in calculating relative abundance; calibrating observers will reduce bias in the trend analyses. For this reason, the observers will switch vessels halfway through the survey such that all observers will be calibrated. The photographs may also be used to determine the size (age) composition of a school. Unfortunately, due to adverse weather conditions, the helicopter was only able to fly on 3 days during the first leg, with a total of approximately nine flight hours. (S. Sexton, FTS 893-7097).

Harbor Seal Tagged With Satellite Transmitter

In early August, staff of the Coastal Marine Mammal Assessment task, the Life History task, and California Department of Fish and Game attached a satellite transmitter tag to a harbor seal at Point Conception, California. The transmitter is being used in a study of harbor seal movements and stock structure. NOAA's Argos satellite system computes locations of the harbor seal by measuring the doppler shift in the transmitter's frequency as the satellite passes overhead. The transmitter should provide a more continuous record of movements than is possible from conventional radio telemetry studies which simply detect presence or absence of transmitters at a few sites.

To increase battery life, the tag transmits only every other day, during two 6 hour intervals when the satellite passes are most frequent. Between August 6 and September 12, (19 days transmitting), the seal's location was estimated 33 times (Figure 1). The precision of the locations depends on numerous factors including the number of successful transmissions during a satellite pass, the spread between the first and last transmissions received in a pass, the strength of the received signals, and the overhead angle of the satellite pass. Most of the points which lie far from the two main clusters (Point Conception and Naples) are poor quality locations resulting when most of the factors listed above were less than optimal.

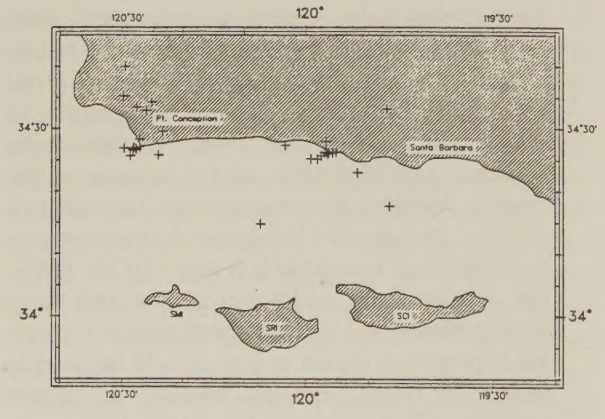

Figure 1. Locations (n=33) of a harbor seal which was tagged with a satellite transmitter at Point Conception, California, in early August 1988.

In addition to the satellite transmitter, the harbor seal carries a VHF radio transmitter on its head. The seal has been located by traditional radio telemetry, twice from a California Department of Fish and Game aircraft and once from the ground. The radio telemetry locations will be used to help determine the accuracy and precision of the Argos satellite locations obtained simultaneously.

When the satellite receives a signal from the transmitter, the message includes a 32 bit data string. Researchers can use the data string to send information gathered by sensors aboard the transmitter. In our case, a salt water switch on the transmitter is used to determine when the animal is submersed and when it is hauled out. The data string sent to the satellite contains the total time during which the animal was hauled out during each of four 6 hour intervals in the day preceding the transmission. The data will reveal much about haulout patterns, as well as allow us to cross check the accuracy of some of the locations which were obtained during intervals in which the animal was known to be hauled out for the entire 6 hours.

Two additional satellite transmitters are planned for deployment at Santa Rosa Island and/or San Miguel Island in October 1988. (P. Boveng, FTS 893-7173, A. Hohn, FTS 893-7088)

FISHERY DEPENDENT ASSESSMENT PROGRAM

Distribution of Dolphins in the Eastern Tropical Pacific

The National Marine Fisheries Service (NMFS) is responsible for managing populations of dolphins in the eastern tropical Pacific be-

cause these populations are subject to incidental mortality during operations of the tuna purse-seine fleet. The Southwest Fisheries Center's (SWFC) primary method for monitoring the status of these populations is by way of research vessel sighting surveys. The research reported here is focused on detecting seasonal changes in distribution of these dolphin populations within their historic ranges, and the role of environmental processes in causing these changes. Elucidation of environmentally-mediated changes in distribution patterns is necessary to allow interpretation of any apparent trends in relative abundance detected by the monitoring program.

The current program is conducted during August-November, annually for 6 years. Previous research vessel surveys were conducted primarily during the opposite seasons of the year (northern winter-spring). Distribution patterns during the winter-spring, as indicated by these research vessel surveys, have been well studied and reported in the scientific literature. A comparison of patterns of dolphin distribution from the summer-fall months to these well known patterns is now possible, because the first 2 years of the current program are completed. Investigation of environmental patterns occurring during the opposite seasons can shed light on observed changes in dolphin distribution.

Maps of summer distribution have been completed for spotted, spinner, striped and common dolphins. These maps show contours of encounter rates with dolphin schools per 100 nm searched. In contrast to the winter distributions from research vessel data, all four target species show an extension westward along 10°N, beyond about 120°W. For spotted and spinner dolphins this westward extension goes to about 155°W, and is accompanied by a reduction in apparent density between the Equator and about 5°N, between 90°W and 125°W. The core of the range for spotted and spinner dolphins, a triangular area off Mexico and Central America, is densely occupied throughout the year. Similar but less extensive areas of density were observed west of 120°W for common and striped dolphins.

These seasonal patterns of change in dolphin distribution coincide with, and are probably causally related to, climatically driven seasonal changes in the environment, specifically in thermocline topography and related processes.

There is a prominent ridge in the thermocline along 10°N, caused by a divergence at the boundary between the westward flowing North Equatorial Current and eastward flowing North Equatorial Countercurrent. The amount of uplifting or "ridging" of the thermocline there varies seasonally with the variation in the currents, such that the ridge is closer to the surface in the late summer-autumn months, and deeper in the late winter-spring months. As the thermocline is brought closer to the surface, more nutrient-rich water is brought into the euphotic zone and productivity is enhanced. It seems reasonable to speculate that the seasonal increase in dolphin abundance west of 120°W is in response to this increase in biological productivity. There is undoubtedly a time lag between the onset of increased productivity and the resultant increase in potential forage for dolphins, but at this point there are not enough data to obtain a better resolution of the annual timing of changes. Direct data on the abundance of the fish and cephalopod prey of dolphins are also insufficient for this task.

In both the winter and summer dolphin distributions, there is a close (but not absolute) association of sightings of these species with certain water mass characteristics at and near the location of the sighting. As a follow-up to this study we are investigating the best set of environmental variables for explaining mesoscale variation in dolphin distribution. We will then examine inter-annual variation in the distribution of these environmental variables, to investigate the possibility that our annual research vessel surveys sample changing amounts of dolphin habitat. If this is so, it may be possible to interpret the annual abundance indices in light of measured changes in amount of habitat sampled for each species.

The analyses to date show that there are measurable associations between the distributions of the target dolphins and the environment, that the dolphin distributions change in time, in apparent association with environmental changes, and that different species segregate, on some spatial-temporal scale, based on habitat differences. Our ability to monitor relative abundance of these populations may depend on knowing how much of the 'true' habitat of each species is censused each year, in relation to other years, for unbiased estimation of abundance trends. This study is an important building block in quantitatively addressing the issue of temporal changes in the distribution of dolphin habitat within the dolphins overall range, which is covered by the sighting surveys.

These results are also very relevant for interpreting abundance indices generated from tuna vessel observer data (TVOD). This is because TVOD have the added complication of monitoring a different part of the eastern tropical Pacific each season and year, based on economics, politics, local weather conditions and what the fishermen perceive as the best location to find and capture tuna associated with dolphins. (S. Reilly, FTS 893-7164)

TOPS Tests Effects of Non-randomness on Line Transect Estimates of Dolphin School Abundance.

Drs. Elizabeth Edwards and Pierre Kleiber, Fishery Biologists, have used a computer model (TOPS: Tuna-vessel Observer Program Simulator) to test the effects on estimates of dolphin school abundance derived by line transect analysis of simulated sightings data of non-random clustering of dolphin schools at various spatial scales and of non-random searching by tuna vessels. Non-random clustering of dolphin schools was effected in the TOPS model by school responses to an underlying environmental topography simulating areas of favorable habitat separated by unfavorable areas. Estimates of abundance were drawn from two different theoretical topographies chosen to bracket a range of likely spatial dimensions in the real habitat (the eastern tropical Pacific Ocean, Figure 1). Two combinations of peak spacing and peak shape were used for the simulations reported here - 1) a simple

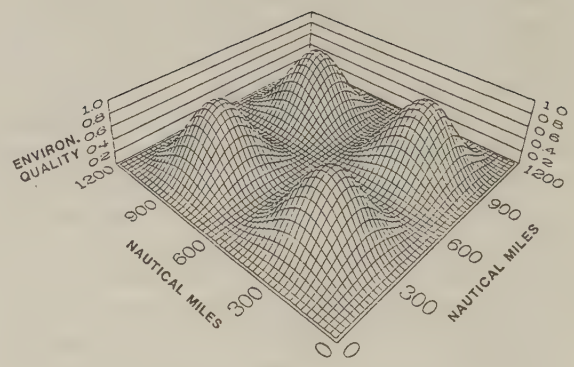

Figure 2a. Simplex environmental topography.

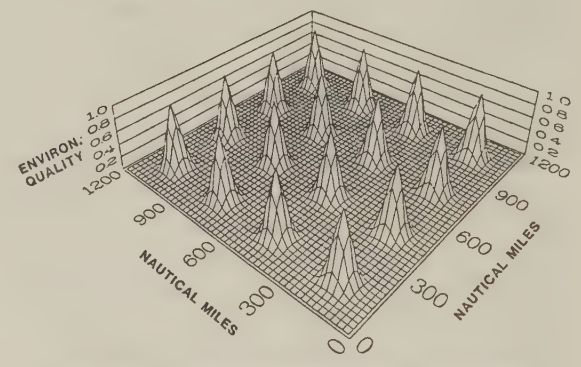

Figure 2b. Complex environmental topography.

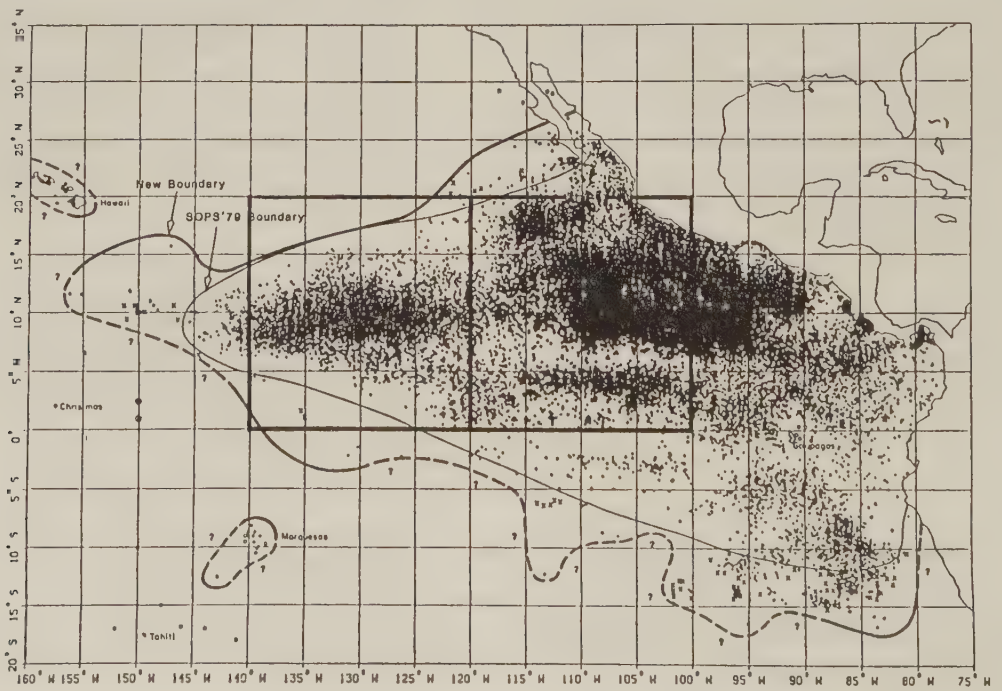
New Boundary
SOPS'79 Boundary
Hawaii
Christmas
Marquesas
Tahiti
160° W 155° W 150° W 145° W 140° W 135° W 130° W 125° W 120° W 115° W 110° W 105° W 100° W 95° W 90° W 85° W 80° W 75° W
35° N 30° N 25° N 20° N 15° N 10° N 5° N 0° 5° S 10° S 15° S 20° S

Figure 1. Area searched by tuna purse-seine fishery, showing positions of all sightings of spotted dolphin 1950-1988. Boxes indicate size of area simulated by TOPS.

topography of four equally spaced peaks with relatively gentle slopes (Figure 2a), and 2) a more complex topography of 16 equally spaced peaks with relatively steep slopes (Figure 2b).

These choices for peak number generate spaces between peak tops of 300 and 600 miles. These spacings were chosen based on approximate distances between clusters of dolphin school sightings from research vessel data (Holt 1987, unpubl. data). Peak steepness was chosen to simulate either slowly changing environmental conditions (gentle slope) versus rapidly changing (steep slope) conditions such as those which pertain at ocean fronts.

Simulations were run either with a stationary topography or with the topography moving in one direction at 1 knot. Moving topographies simulate movements of major ocean features.

Edwards and Kleiber also tested the effects of three different types of data stratification by encounter rate on the abundance estimates. These types included 1) no stratification (used as a control), 2) stratification by raw encounter rate per 1 degree square, and 3) stratification by smoothed encounter rate per 1 degree, using a smoothing algorithm developed recently by researchers at the Inter-American Tropical Tuna Commission.

Model results showed that abundance estimates derived by these methods can be seriously biased by 1) relatively small-scale non-random searching by vessels and clustering of schools and 2) choice of data stratification algorithm. The most severe biases resulted from interactions between relatively close clustering of dolphin schools and a smoothing and interpolation algorithm developed to estimate school abundance in areas receiving little search effort (Figure 3).

If biasing factors in the school-vessel system remained consistent through time, accurate estimates of change in school abundance could be derived despite bias in estimates of absolute abundance. But serious biases arose in a simple ratio estimator of change in abundance when system biases changed even slightly (Figure 4). The results provide an explanation for a biologically unlikely dip in abundance estimates ob-

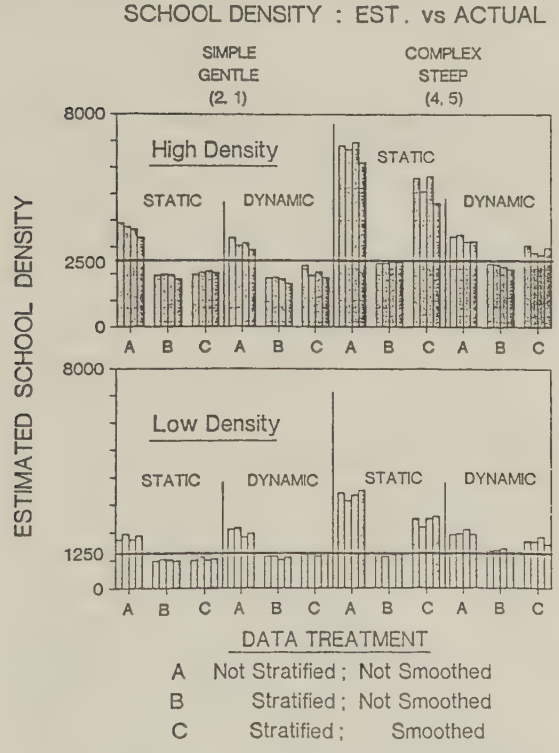

Figure 3. Estimates of school abundance under different conditions in TOPS model. Sets of four columns are replicates.

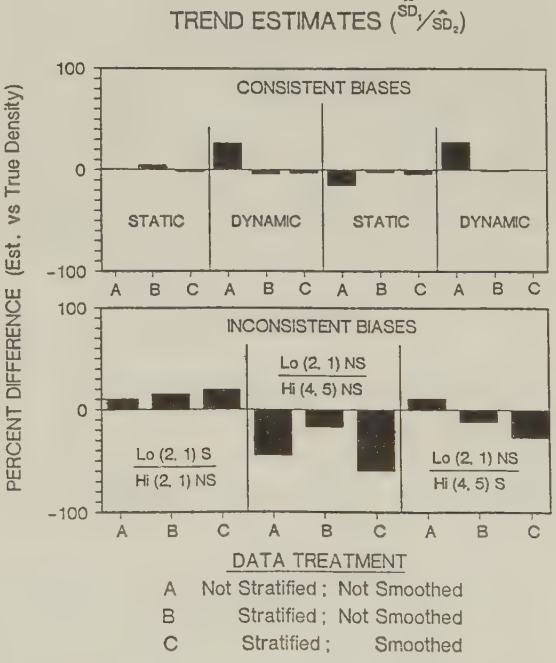

Figure 4. Ratio estimates of "trends" in dolphin school abundance under different conditions in TOPS model. Cases with consistent bias simply compare estimates at low and high densities. Cases with inconsistent bias compare estimates where other conditions changed in addition to density.

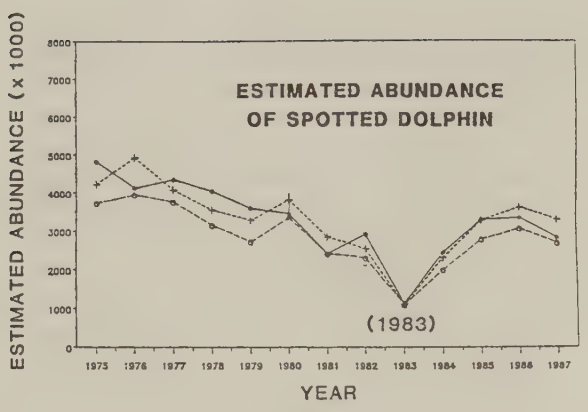

Figure 5. Estimates of spotted dolphin abundance in the eastern tropical Pacific Ocean (from Buckland and Anganuzzi 1988).

served during the El Niño of 1983 (Figure 5). Researchers had suggested previously that the dip might be due to differences during 1983 in the clustering characteristics of dolphin schools. The TOPS model results quantify this suggestion and show that it can be a significant effect.

TOPS model results emphasize the need to understand patterns of dolphin school distribution in smaller scales of space and time than have been studied previously, and to develop smoothing algorithms more robust to the effects of small-scale nonrandomness in school distributions. These research foci will be considered strongly in proposals for future work. (L. Edwards, FTS 893-7099).

HONOLULU LABORATORY

Honolulu, Hawaii

INSULAR RESOURCES INVESTIGATION

Assessment of Hawaiian Deepwater Shrimp Completed

Since early in this decade, there has been a continuing interest in developing a commercial fishery for *Heterocarpus* shrimp in Hawaii, particularly the much desired *H. laevigatus*. However, fishing activity has been sporadic and has met with limited success, despite 75 metric tons (t) of *H. laevigatus* being landed by a vessel in 1983-84. Various fishing, processing, and marketing problems have hampered the development of a viable large-scale trap fishery for deepwater shrimp. These events highlighted the need to determine the developmental potential of this fishery and to prepare a fishery management plan for Hawaiian shrimp stocks. In response to these needs, the Honolulu Laboratory initiated a stock assessment program in 1985 for *H. laevigatus* in the Hawaiian Archipelago.

Analysis of the catch and effort data on *H. laevigatus* in the Hawaiian Archipelago was recently completed by Darryl T. Tagami, Operations Research Analyst, and Stephen V. Ralston, Task Leader of the Insular Stock Assessment Program. These data were collected in 1985-88 during four research cruises of the NOAA Ship *Townsend Cromwell*. Results of their study provide estimates of exploitable biomass and maximum sustainable yield for the entire archipelago (Figure 1). Areas of potential shrimp habitat were measured between the 250- and 500-fathom (468- and 915-m) isobaths: 3,145 nmi^2 in the main Hawaiian Islands (MHI) and 2,966 nmi^2 in the Northwestern Hawaiian Islands (NWHI). Standardized statistics on catch per unit effort (CPUE) were developed for all locations in the archipelago (Figure 2). The total exploitable biomass was estimated to be nearly 500 t, with 70% of the stock resident in the MHI. Mean densities were calculated to be 109 kg/nmi^2 in the MHI and 50 kg/nmi^2 in the NWHI.

Although these estimates appear surprisingly low, trapping results indicate that the shrimp are extremely vulnerable to trapping and may be easily depleted; catchability, q, was estimated as 0.028 nmi^2/trap-night. The maximum sustainable yield for the fishery was determined to be about 125 t annually. When fully exploited, the fishery could produce about $1 million ex-vessel at current market prices. This estimate of maximum sustainable yield is considerably lower than previous estimates (400-1,000 t/yr); however, Tagami and Ralston show that it is the most realistic figure to date. Better estimates can be developed when further systematic surveys provide additional CPUE data, which can be pooled with the existing shrimp CPUE database. Likewise, an independent confirmation of the catchability coefficient is planned. Results of the shrimp stock assessment study are presented in "An assessment of exploitable biomass and projection of maximum sustainable yield for *Heterocarpus laevigatus* in the Hawaiian Islands" (Southwest Fisheries Center Administrative Report H-88-14) by Tagami and Ralston. Using the research findings in this report, the

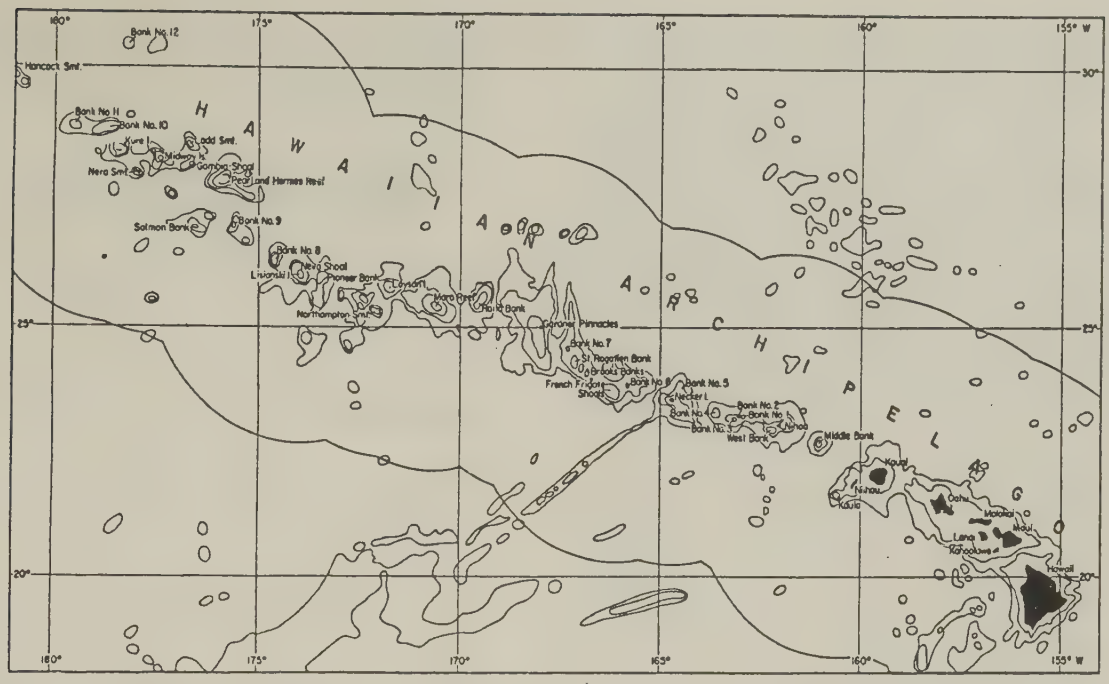

Figure 1. The Hawaiian Archipelago, including the Northwestern Hawaiian Islands. The approximate positions of the 100-, 1,000-, and 2,000-fathom isobaths and the U.S. Fishery Conservation Zone are shown on the map.

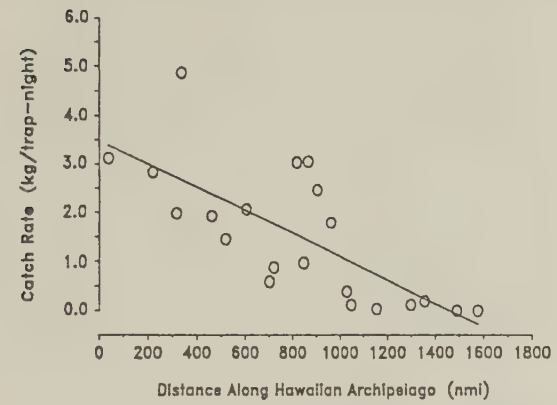

Figure 2. The relationship between standardized $CPUE_I$ of *Heterocarpus laevigatus* and distance up the Hawaiian Archipelago.

Western Pacific Regional Fishery Management Council (Council) can proceed with development of a fishery management plan for the deepwater shrimp resource. (D. Tagami (808) 943-1242)

FISHERY MANAGEMENT RESEARCH PROGRAM

Economics of Enforcement and Compliance

Jon Sutinen, visiting faculty fellow in economics and Director of Graduate Studies at the University of Rhode Island's Department of Resource Economics, is completing a 2-month cooperative research project at the Honolulu Laboratory and the East-West Center's Resource Systems Institute. Sutinen, whose research has focused on the economics of regulatory enforcement, is preparing a typology of factors affecting compliance with, and the enforceability of, fisheries regulations. His work will be presented in a research report of the two institutions. (S. Pooley (808) 943-1216)

Economics of Effort Management in Lobster Fishery

Karl Samples, Associate Professor with the University of Hawaii's Department of Agricultural and Resource Economics, and John Sproul, Fisheries Economist with the the Council, have completed their analysis of effort regulation in Hawaii's lobster fishery. Samples and Sproul considered five types of effort control (licensing, trip limits, trap limits, season closures, and area closures). They "modeled" the effects of these effort controls through a functional expression relating annual trap-night production to six vessel operating characteristics and to fleet size. They quantified the model by using a simple bioeconomic description of declining catch rates, based on fishery data, vessel charac-

teristics, and cost and revenue data from the Honolulu Laboratory's economic research.

Samples and Sproul concluded that only licensing would have a positive impact on industry profits and also increase capacity utilization within the industry. The other methods of effort control would have a neutral impact on vessel profits and a negative impact on capacity utilization. In all five cases, economic optimization requires a substantial reduction in overall fishing effort. The license limitation reduces the economic dislocation likely to occur as a result of this reduction in fishing effort.

Their analysis is presented in "An economic appraisal of effort management alternatives for the Northwestern Hawaiian Islands commercial lobster fishery" (Southwest Fisheries Center Administrative Report H-88-12C). This report is the last of five in a cooperative research project with the University of Hawaii, Council, and Honolulu Laboratory. (S. Pooley (808) 943-1216)

Status of Hawaii's Lobster Fishery at Mid-year

From January through July 1988, 12 trips were taken by vessels in the lobster fishery in the NWHI, according to Biological Technician Raymond P. Clarke. Eight vessels were active in the fishery during the same time period. The number of trips per vessel is smaller, and the number of vessels is slightly smaller in 1988, compared to the same period in 1987. Fishing effort (in trap-hauls) declined slightly over the same period in 1987. (Traps were modified in 1988 to reflect the new regulation requiring escape panels.)

Landings of legal-sized spiny lobsters more than doubled in 1988 compared to last year, while landings of slipper lobsters (all sizes) fell 15%. (Size limits for slipper lobsters were implemented this year.) Legal-sized slipper lobsters averaged 70% of the catch of slipper lobsters in 1988; thus, landings of "keepable" slipper lobsters declined 42% since 1987. Nonetheless, combined total landings of "keepable" (legal-sized) spiny and slipper lobsters increased by 34% since 1987. Total CPUE through July 1988 was 1.31 lobsters/trap-haul compared to 0.81 lobster/trap-haul in 1987. The CPUE for spiny lobsters was 0.89 lobster/trap-haul, compared to 0.52 in 1987. Total slipper lobster CPUE was 0.42 lobster/trap-haul in 1988, compared to 0.49 in 1987. The CPUE of legal-sized slipper lobster was 0.29 lobster/trap-haul through July 1988; no comparable figures are available for periods prior to the implementation of the size limit. (R. Clarke (808) 943-1213)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

PHYSICAL OCEANOGRAPHY

PFEG Oceanographer Completes Field Program for Antarctic Marine Ecosystem Research at the Ice Edge

David Husby, Oceanographer with the Center's Pacific Fisheries Environmental Group, participated in Leg 1 of the final cruise of the Antarctic Marine Ecosystem Research at the Ice Edge Zone (AMERIEZ), June 4 to July 5, 1988, in the eastern Scotia Sea and the northern portion of the Weddell Sea, aboard the research vessel R/V *Polar Duke* (Figure 1). The objectives of this multi- disciplinary, multi-year program are to investigate the factors responsible for the enhanced biomass and productivity at the pack-ice edge and to quantify the seasonal variability in the ice-edge ecosystem. NMFS participation in this program is under the direction of the NOAA/NMFS Antarctic Living Marine Resources Program office; funding for the field work was provided by the National Science Foundation. Researchers from the NMFS Northwest and Alaska Fisheries Center also participated in marine mammal research within the 1988 AMERIEZ survey.

The previous two field surveys, November-December 1983 (austral spring) and March-April 1986 (austral autumn), were conducted during periods of a retreating ice edge and maximum retreat of the ice edge, respectively. The purpose of the 1988 survey during the austral winter was to determine the physical, chemical, and biological characteristics of the marginal ice edge zone associated with an advancing ice edge. Husby was responsible for carrying out the physical oceanographic sampling which consisted of conductivity, temperature and depth (CTD) profiling and water sampling at discrete depths with a rosette sampler. The objectives of the physical oceanography component of the survey were to provide the other components

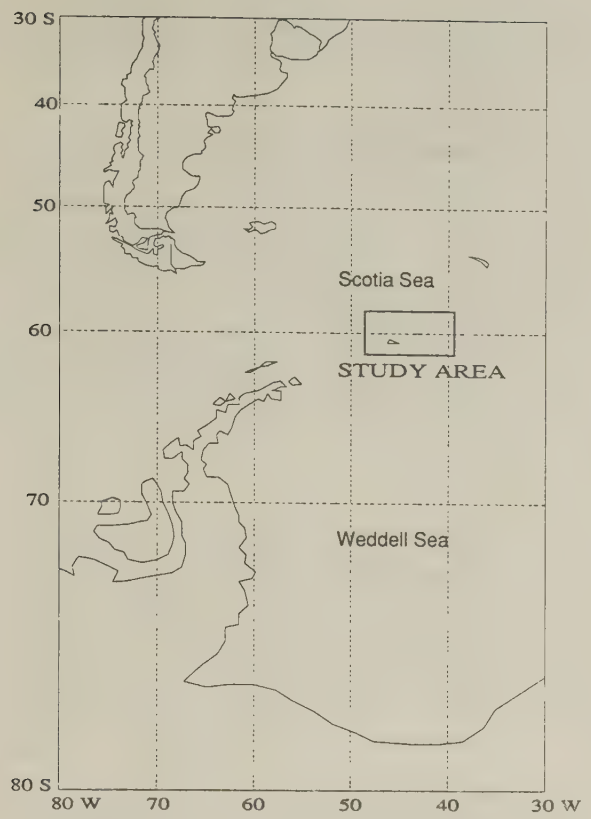

Figure 1. Geographical location of study area for AMERIEZ 88, Leg 1 survey during June 4 to July 5, 1988.

with the vertical distribution of physical parameters in the euphotic zone to aid in their sampling schemes and to obtain sufficient data to characterize the regional and mesoscale circulation in the upper 1500 m of the water column.

A total of 55 CTD/hydrocast stations was accomplished, primarily within the pack ice, during the Leg 1 survey. Two south-to-north transects were completed with stations extending from within the pack ice to open water, over a distance of about 300 km. An additional activity was the placing of ARGOS data acquisition platforms (transmitters) upon two small ice floes. These transmitters are interrogated daily by the ARGOS satellite and are intended to provide several months of information on the drift of the pack ice. The other components of the AMERIEZ program consisted of assessment of the bacterial, microfloral and faunal populations in the ice and upper water column, sampling of the macrozooplankton with hydroacoustic gear and net tows, micro-nutrient and primary productivity analyses in the upper 150 m, nekton sampling in the upper 1000 m by Tucker trawl, seabird census and collection (stomach content analysis), marine mammal census and collection, and sea ice measurements.

Preliminary results from the survey indicate the presence of mesoscale eddies or meanders beneath a deep (80-120 m) mixed layer along the N-S transects associated with the effects of the Scotia Ridge and the confluence of Weddell and Scotia Sea waters. Primary productivity was generally very low, but accumulation of chlorophyl-a in ice (from ice cores) was 5 times that of the underlying integrated water column values (to 100 m). However, some open water stations showed 2-3 times the integrated chlorophyll-a of the under-ice stations. Lowest concentrations of krill, *Euphausia superba*, were found in deep pack ice and open water greater than 100 km from the ice edge. Higher concentrations of krill were observed along ice edge and in open leads in pack ice. Pack ice appears to be an important habitat for larval krill in the winter. Seabird biomass at the ice edge and penguin biomass at leads in pack ice equalled or exceeded some of the highest known for summer months. (D. Husby (408) 646-3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

"Sundown" Sets Being Analyzed

The Multispecies Data Collection and Evaluation Program has recently begun a study comparing dolphin mortality between day sets and "sundown" sets. These sets are made during purse-seining operations for yellowfin tuna in the eastern tropical Pacific. Sundown sets are sets made where the backdown operation is performed in darkness. Different types of lights (spot, flood, etc.) may be used during a sundown set to aid in the release of dolphins during backdown. Beginning July 1, 1986, all U.S. purse seiners, certified to set on dolphin associated tuna schools, were required to use floodlights during a night backdown. One of the major questions to be addressed by this study is: what

affect does the use of lights during backdown have on dolphin mortality?

While the majority of the analysis is yet to be completed, thus far the staff has some interesting statistics. These include the average elapsed times from "net-let-go" to "start-backdown" and from "start-backdown" to "end-backdown" for various kinds of dolphin sets, namely daytime sets, sundown sets without lights, and sundown sets with lights. These statistics are based on 162 NMFS-observed cruises from 1982 through 1987. Some of the results are:

Dolphin sets		**Average duration (minutes)**	
Kind	Number	Net-let-go to start backdown	Start-bd to end backdown
Day	4948	77	14
Night-no lights	106	76	14
Night-non-floodlights	243	85	18
Night-floodlights	281	81	20
Overall	5578	78	15

Our preliminary conclusions from these data are that elapsed time for a set is relatively independent of time of day or whether lights were in use. The next step of the analysis will involve looking at various measures of dolphin mortality rates in relationship to the above kinds of sets. This project is being led by Al Coan with assistance from Randy Rasmussen, Rick Tauber and Ken Wallace. (K. Wallace, FTS 893-7051)

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

Scientists at the International Billfish Symposium II Report Latest Findings

Scientists from 14 countries gathered in Kailua-Kona, Hawaii, August 1-5, 1988, to review their latest information on the biology of billfishes and the fisheries. It has been 16 years since a similar meeting was held on the topic and since then the information base and fisheries have changed.

Present at this recent International Billfish Symposium II meeting were David Au, Norman Bartoo, David Holts, Gary Sakagawa and James Squire, Jr. of the Pelagic Fisheries Resources Division. They participated in the discussion as well as contributed results of their work on stock conditions, trends in fisheries, and behavior of swordfish and striped marlin. Summaries of their contributions are as follows:

"Trends in fisheries for swordfish in the Pacific Ocean" by Gary T. Sakagawa.

Swordfish is caught in significant amounts only by commercial fishermen. In the Pacific, the catch peaked at 24,300 mt in 1961. The discovery in 1970 of high levels of mercury in swordfish steaks resulted in reduced consumer demand and the catch declining to 11,000 mt in 1971. This decline was short lived, however, as demand returned and production increased to 21,000 mt in 1986.

Approximately 70% of the Pacific swordfish catch is taken with longline gear that is directed at catching tunas, while 30% is taken by surface fishing gears, such as harpoon, drift gillnets, and handlines, directed at catching large pelagic species. Hence, there is little directed fishery for swordfish. The exception is the U.S. fisheries. Both drift gillnets and harpoons are used by the U.S. fisheries off southern California to target swordfish. The total catch for the fisheries was 2,600 mt in 1986 and 1,600 mt in 1987. About 96% of this catch is made by the drift gillnet fishery.

The outlook for the Pacific fisheries is mixed. The world market for swordfish is strong, so prices should remain high. Greater yields appear to be available from the Pacific swordfish stocks as they are in good condition. However, increased production by coastal fisheries operating in traditional areas appears unlikely owing to limitations of the gears and suitable fishing areas. In contrast, longline fisheries have considerable potential for increased catches of swordfish. The fisheries currently are largely day-fishing operations and directed at catching tunas. They can be directed to night-fishing operations in certain regions to target swordfish.

For the U.S., the outlook is not good. Pacific swordfish production is severely limited because the gears used are only effective in a limited coastal area. Furthermore, government restrictions on use of alternative gears and on incidental catches discourage efforts to expand the fisheries and increase production.

"An assessment of the Pacific swordfish resource" by Norman Bartoo and Al Coan.

The Pacific swordfish resource is assessed using catch-per-unit-effort (CPUE) realized by the Japanese longline fleet as an indicator of abun-

dance. Lack of data for other fisheries and absence of reliable size sampling limits the assessment to CPUE trends and comparisons. A time series of data from 1952 through 1980 is used. This series of data is not consistent throughout due to changes in the fishery and fishing strategy. Attempts to standardize or calculate effective fishing effort are rejected because of changes which occurred in the fishery and because swordfish are, depending on location, both a target species and an incidental catch. Nominal CPUE (numbers of fish caught per 10,000 hooks fished) is used in conjunction with a stratification methodology which separated high catch rate "target" areas from low catch rate incidental catch areas. Two stock structure cases were considered: 1. Pacific-wide and 2. three stocks: northwest, east and southwest.

Results for the whole Pacific case show CPUE for target areas increased slowly from the early 1950's through the early 1960's, then dropped approximately 1/3 in the 1963- 1965 period and has remained level since. The change in CPUE levels in the early 1960's corresponds to operational changes in the longline fleet. The CPUE for incidental catch areas shows a long-term very slow increase without the abrupt change noted in the target area CPUE.

Results for the three stock case show that the CPUE pattern in target areas in the northwest Pacific follows the total Pacific case. This is because this area produces the bulk of the catch. The CPUE in the east Pacific was very erratic in the early fishery years. After 1965, increased effort and operational changes reduced some of the CPUE variability and produced a near level trend in CPUE. The CPUE trend in the southwest Pacific is erratic (more so in the earlier years of the fishery) but flat since 1970.

The conclusion reached is that none of the data examined indicates the stock(s) have been exploited heavily enough to cause a noticeable decline in CPUE through 1980. Sketchy data for Taiwan and Korean longline fleets covering the 1975 to 1985 period show an extension of the Japanese data trends for the low CPUE stratum. The conclusion that no decline is evidenced by data examined may be conservative because of the increase in deep longlining since 1974, which when corrected for, may elevate CPUE values in the last part of the time series. The inclusion of detailed Japanese data from 1980-1988 could be useful in confirming these conclusions.

"Activity patterns of striped marlin in the Southern California Bight" by David Holts and Dennis Bedford.

During September 1982, a striped marlin *(Tetrapturus audax)* was tagged with a sonic transmitter and tracked by National Marine Fisheries Service (NMFS) biologists in waters off southern California. This was the first time this species has ever been tracked. In 1986 and 1987 an additional 11 striped marlin were tagged with sonic transmitters, also off southern California. This renewed effort was conducted as a joint program of the NMFS and the California Department of Fish and Game (CDF&G). Eight marlin were successfully followed for periods ranging from 20 to 48 hours and covered 254 nautical miles.

No single repetitive behavior was found to be characteristic of all the marlin tracked during this study, although a few behaviors were common to several fish. These were classified into three broad categories including occasional behaviors, periodic behaviors, and those influenced by environmental parameters.

Two patterns of horizontal movement emerged from these tracks. Five of the eight moved predominantly in one direction after tagging, usually south. The other three marlin remained in the vicinity where they were first captured. Distances traveled ranged from 22 to 57 nautical miles at an average speed of 1.18 kts.

The greatest activity was observed during the late afternoons, when some of the marlin swam rapidly downwind and downswell in a behavior known to fishermen as "tailing" or "breezing." General activity of all fish slowed during the night. Several fish exhibited behavior which might be characterized as "sleeping", the fish remaining motionless, just below the surface, for 1 to 4 hours. Vertical movements during day and night hours showed some consistency among all marlin tracked. These striped marlin showed a preference for warm surface water and remained within the mixed layer more than 85% of the time. Four fish spent their night time hours at a somewhat greater depth than during the day time.

Vertical movement tended to be exaggerated and erratic for up to 2 hours after tagging. Beyond this time, the fish assumed a behavioral pattern which remained consistent throughout the duration of the track. We believe this pattern indicates that the trauma induced by capture and tagging is short lived and tracks of as little as 24 hours should faithfully reflect "normal" marlin behavior.

"Management of striped marlin resources in the northeast Pacific - a case for local depletion and core area management" by J. L. Squire and D. W. K. Au.

The amount of decrease in CPUE that occurred in the core area (concentrated fishing area) and elsewhere in the eastern Pacific during the years of active longline fishing was probably due less to declining overall stock than to changes in catchability or availability experienced by the expanding fishery in the localized area. The catch-

effort relationship suggests no slowing of catches with increasing effective effort. Furthermore there was not a clear increasing trend in effective effort from 1969 to 1976 in either index or core areas.

Catchability/availability changes are likely a function of evolving fishing tactics and of fish behavior. In particular, the rapid rise of CPUE in the small sport and starting-up joint venture fisheries, after the cessation of longlining in Mexico's EEZ, was likely due to fish populations building up first and quickly in favored localities, which then become the natural focus of any renewed fishing. As these "hot" spots are again fished down, the fishery spreads out to include surrounding, larger and lower catchability areas. Overall CPUE thus at first decreases rapidly, then more slowly (such events are predictable from the tenets of optimal foraging theory). The resulting CPUE's can therefore change rather strikingly with changes in the fishery, but not necessarily as a reflection of changes in overall stock size. Thus, adjacent coastal sport fisheries on the inner side of the aggregation area for striped marlin and whose fish are therefore first subjected to an external fishery are affected.

The eastern Pacific striped marlin therefore is probably not overexploited. Nevertheless, its catch rates and fishery behavior warrant continual monitoring. This may be accomplished in relatively localized key or core areas, in which management measures may also be feasibly implemented. Such measures would at best be implemented within the context of an international management regime. Lacking that, a coastal state may opt to bear the responsibility, if it can be compensated by an ability to mitigate declines in the local catch rate. Core area management off Mexico would recognize the importance of areas toward which fish aggregate, and that in such areas differences in catchability/availability affect fishing tactics and CPUE trends. Quite possibly and in general, changes in catchability from the fishing down of localized hot spots may explain more of the proverbial "good old days" of fishing than the usual "fishing up" explanation.

"Migration trends of striped marlin in the Pacific Ocean" by James Squire and Ziro Suzuki.

From examination of the geographical locations of the major spawning areas, the distribution of length frequency modes, differences in morphometrics, and changes of high CPUE values from area to area in the commercial longline fishery, a generalized migration pattern can be hypothesized:

The major spawning area appears to be in the western Pacific (north-central to western). There may be some spawning in the eastern Pacific, but the extent of spawning there is unknown. In the southwest Pacific, a spawning area is also identified; however, as in the case of most areas, its magnitude and contribution to the total resource is unknown. Only a small percentage of young fish is caught in the northeast, southeast and southwest Pacific, while a large percentage of small fish in the catch is observed in the north-central Pacific, the percentage declining in the northwest and south-central Pacific. From larval and fishery observations it would appear that the small fish are more common from the central-Pacific westward. Young fish (larvae or juvenile) may migrate or drift west from the major spawning area in the north equatorial current and, as they grow, some may move into the northwest and south-central Pacific. However, sizable numbers of juvenile striped marlin must migrate to the southeast and northeast Pacific, areas that are most productive for fish of 170 and 180 cm (eye-fork length).

Changes in areas with high CPUE values give some indications of migration that parallels the seasonal changes of the total environment (physical and biological) i.e. poleward during the northern and southern summers in the respective hemispheres. The extent of longitudinal migration during seasonal migratory events is unknown. Changes in migration patterns with growth in size are possible.

From length-frequency data, modal shifts in length (eye-fork length) can be observed, which indicates a shifting of individuals over time from the north-central to the northwest and south-central Pacific, and to the north and southeast Pacific and then to the southwest Pacific. Modal data would indicate that the north-central, northwestern and south-central areas have populations of both older and young fish, while the north and southeastern areas have intermediate-sized individuals.

In their publication on tuna and billfish, Joseph, Klawe and Murphy (1979) describe tuna as a "wandering fish " and this description could also be applied to striped marlin. However, from evidence available from tagging, striped marlin cannot be described as "highly migratory" in the sense that rapid trans-ocean migrations are common as it is for such species as bluefin tuna *(Thunnus thynnus)* and albacore tuna *(Thunnus alalunga)*.

Evidence would indicate a net movement from areas having a high percentage of smaller fish to areas with larger fish. The long-term interchange rate between the north-central Pacific, an area with smaller fish, to the southeast and northeast Pacific, and the movement of fish back to the west as they grow, appears not to be rapid. The larger sizes (200 cm) are not present in the north and southeast Pacific, indicating that these areas are probably feeding rather than spawning areas.

After a period of time in the eastern Pacific the maturing fish probably wander back to the major spawning areas, and the larger sizes thereafter tend to remain closer to the spawning areas in the western Pacific. Seasonal shifts of migration, based on changes in the trend of modal lengths, appear to be possible. The possibility of an identifiable race in the southwest Pacific, based on pectoral fin lengths, exists, although other areas appear to show a gradation or cline of pectoral fin lengths.

The migration patterns of striped marlin appear to vary with a general movement over time that would indicate a stock relationship between all areas in the Pacific. This relationship may be similar to that of yellowfin tuna in the Pacific as described by Suzuki, Tomlinson and Honma (1978) as "semi-independent subpopulations" in the high abundance areas. The relationship between stocks will be difficult to determine because throughout the Pacific these fish seasonally move poleward and between feeding and spawning areas, alternately increasing and decreasing in availability in the geographical areas which are centers for feeding or spawning. Depending upon maturity and feeding conditions some fish will range farther than others, and it is possible that most may move, in time, to other areas of the Pacific. However, movements, overall, are diffusive rather than migratory, and this should allow for management by "stocks."

"Trends in fisheries for billfishes in the Pacific" by S. Ueyanagi, R. S. Shomura, Y. Watanabe and J. L. Squire.

Billfishes are taken by a wide variety of fishing gear types; however, longline gear has been the principal method of capture over the past several decades. In recent years, the shift in target species of the longline fishery toward bigeye tuna by using deeper fishing gear has added a complexity to the use of catch and effort statistics as measures of resource abundance. Although Japanese longliners have shifted their fishing effort to high-priced tuna species, they have been replaced in some areas by Taiwanese and Korean longliners.

The gill-net, purse seine, and recreational fisheries have experienced changes in billfish catches. The catch of billfishes by the Japanese gill-net fishery declined in recent years, principally because of a shift in target species to the albacore tuna. A newly developed tuna purse seine fishery in the western central Pacific has resulted in the capture of small amounts of billfishes by the Japanese single purse seine vessels. Finally, the billfish catch by a large, widely dispersed recreational fishing community in the Pacific may be increasing; however, details of magnitude in catch and effort are still lacking. (N. Bartoo, FTS 893- 7073)

1988 Sonic Tracking of Billfishes off Southern California Begins

David Holts, Fishery Biologist, reports the 1988 striped marlin *(Tetrapturus audax)* season started off with a bang. In a continuing project, biologists from the Southwest Fisheries Center and the California Department of Fish and Game were successful in tracking a large striped marlin on the first of seven cruises planned this year. The R/V *Yellowfin*, an 80 ft research trawler, has been chartered as the tracking platform.

This marlin initially moved northeast after release but soon turned south covering 35 nm and ending 5 nm south of the U.S.- Mexican border. It spent virtually all of the daylight hours between the surface and 3 m. All of the nighttime hours were spent between 8 and 22 m. Periods of greatest activity were in the late morning and early afternoon. Activity was low for several hours around midnight. The observations of this fish matched closely with results obtained in previous tracks of striped marlin.

The project objectives are to identify differences in the behaviors of striped marlin and swordfish *(Xiphias gladius)*. Data on the horizontal and vertical movements are being correlated with periods of high and low activity, with feeding and with the physical parameters of their environment.

This year three of the week-long cruises are directed toward swordfish. A commercial swordfish harpoon boat will assist in tagging free swimming swordfish. (D. Holts, FTS 893-7186)

FISHERY MONITORING AND EVALUATION PROGRAM

90th Issue of the Tuna Newsletter Published

Wes Parks, Editor of the Southwest Region/Southwest Fisheries Center Tuna Newsletter, with the assistance of Diane Pickelsimer and Ken Raymond, SWFC, recently completed and distributed Tuna Newsletter Issue 90 to some 500 persons on the Newsletter's mailing list. Issue 90, 12 pages in length, contained the Newsletter's quarterly statistical report on the U.S. tuna industry, three contributed articles and a number of news items, contributed by the staff of the NMFS Branch of Foreign Fisheries Analysis.

In "The U.S. tuna industry in first quarter 1988," Parks and Pat Donley, SWR Terminal Island, described the current condition of the U.S. fleet. They reported that 68 vessels of the U.S. tropical tuna purse seine fleet were at sea at least one day during the first quarter of 1988. Receipts of all tuna species by U.S. canneries during the first quarter totaled 118,505 short tons (st), approximately the same as long-term (1983-1987) average first-quarter receipts. Domestic sources provided 41% of total deliveries, imports provided 59%.

Skipjack and yellowfin tuna together comprised 80% of deliveries of raw tuna to U.S. canneries in the first quarter. The western Pacific Ocean was the major fishing area for tuna delivered to U.S. canneries. Tuna fisheries of eight nations provided 92% of the raw, frozen tuna imported to U.S. canneries in the first quarter. Major suppliers were Taiwan, France and South Korea.

Imports of canned tuna to the U.S. are running ahead of both 1988 imports and recent long-term average imports. By the end of the first quarter of 1988, imports of canned tuna, not in oil, exceeded the 1988 quota of 85.2 million pounds by 29%.

In the "South Pacific Tuna Act of 1988," E. Charles Fullerton, Director of the SWR, reported details of the new tuna access treaty. The treaty between the United States and 16 member states of the South Pacific Forum authorizes U.S. tuna vessels to fish within fishing zones of a large region of the South Pacific (Figure 1). The treaty was signed on April 2, 1987. On June 7, 1988, President Reagan signed the South Pacific Tuna Act of 1988 (PL. 100-330), implementing provisions of the treaty.

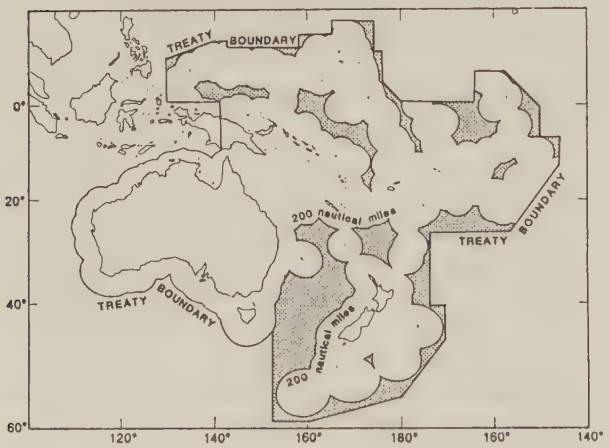

Figure 1. Approximated boundaries of the South Pacific-U.S. Tuna Treaty. Source: U.S. Department of State (7195 7-87 State (INR/GE)).

The treaty will be in effect for 5 years. Under the terms of the treaty, the United States will pay the Pacific Island States $50 million in economic assistance over the 5 years of the treaty. In return for fishing rights, the U.S. tuna fishing industry will contribute $2 million in license fees and technical assistance during the first year of the treaty.

The South Pacific Tuna Act provides the framework for implementing treaty agreements. Key ingredients are for U.S. purse seine vessels to obtain licenses, issued by the Forum Fisheries Agency (FFA), to fish in the treaty area and to keep records of activities in treaty waters. In the initial year under the treaty, 40 vessel licenses will be available at a minimum of $50,000 each with an additional 10 licenses available for $60,000 each. NMFS has opened an office in American Samoa to collect reports and assure their timely submission to FFA. Completed vessel reports are collected by NMFS representatives who submit the records to FFA.

In "A review of the fishery for tropical tunas in the eastern Pacific Ocean," James Joseph, Director of Investigations of the the Inter-American Tropical Tuna Commission, reviewed events leading to the establishment of international management of tuna fisheries in the eastern Pacific.

Joseph outlined the early days of the tuna fishery of the eastern Pacific Ocean which had its beginning off southern California shortly after the turn of the century, and by 1940 had expanded as far afield as the equator and several hundred miles offshore.

In the 1940's, nations of the region began to express concern over the effect that this fishery might be having on the stocks of tuna and of the baitfish used to catch them. This eventually led to Costa Rica and the U.S. entering into the agreement which established the Inter-American Tropical Tuna Commission.

When the conservation program began, the fleet consisted predominantly of U.S.-flag vessels. Later, other countries, particularly the Latin American coastal states, increased their fleets and the coastal nations began to extend their jurisdictions seaward. As more nations extended their jurisdictions to 200 miles, and as the fleets of Latin American nations continued to expand,

dissatisfaction with the conservation program increased. Finally, beginning in 1977, Mexico and Costa Rica held a series of meetings to draft a new treaty. No agreement was reached, and the scheme was abandoned in 1979.

For the last 10 years there has been no conservation program in the eastern Pacific. During this time there have been several attempts at formulating a new framework for tuna management. Notable attempts were the San Jose' Agreement, or Eastern Pacific Ocean Tuna Fishing Agreement (EPOTFA), drafted by Costa Rica, Panama, and the United States and an initiative by OLDEPESCA, the fisheries arm of the Sistema Econo'mico de Ame'rica Latina (SELA). So far agreement on a draft treaty acceptable to all has not been reached.

In "The developing U.S. yellowfin tuna fishery in the Gulf of Mexico and U.S. South Atlantic region," Chuck Adams, Florida Sea Grant, University of Florida, described the growth of this new U.S. fishery. Adams reported that catches in the U.S. longline fishery for yellowfin tuna based in the southeastern U.S. have increased seven-fold since 1980, primarily since 1982. The predominant species taken in the fishery are yellowfin (81%) and bluefin (5%) tuna. The major tuna producing states in the region have been Florida, Louisiana, and North Carolina.

Yellowfin tuna landings increased from 119,000 pounds in 1980 to 8.8 million pounds in 1987. During the same period, dockside value increased from $164,000 to $16.6 million. The majority of the yellowfin production (93% for 1987) comes from the Gulf of Mexico. Among states, Florida has been the leader in yellowfin tuna production.

Production of yellowfin tuna in the fishery appears to be seasonal with peaks in the summer and early fall months. Dockside prices for yellowfin tuna in the fishery also appear to be seasonal. Prices tend to be higher from November to March, when production is lowest, and lower in June to October, when production is highest.

There have been reports of dockside prices of up to $3.75 and $5.00 per pound for boat-run (i.e. ungraded) and grade 1 fresh yellowfin tuna. While the available data do not show these prices, they do suggest that prices are generally stable or increasing on a yearly basis, even as production continues to increase. For further information, see SWR/SWFC Tuna Newsletter, Issue 90. (W. Parks, FTS 893-7074)

TIBURON LABORATORY

Tiburon, California

Progress on Bodega Bay Laboratory Site Acquisition

On Wednesday, August 17, Drs. Alec MacCall and Mickey Eldridge joined Deputy Director John Carr and Southwest Regional Director Charlie Fullerton in Berkeley for a meeting with the Bodega Marine Laboratory (BML) Administrators and University of California Assistant Vice Chancellor for Business Affairs, Janet Hamilton, and her staff. The purpose of the meeting was to explore arrangements for land acquisition at Bodega Bay in order to build a federally-owned fishery laboratory.

The University of California people had several recent examples of long-term lease arrangements which have been acceptable to the federal government. Accordingly, their lawyers have begun drafting a lease which they expect to be available for review in early September. Their opinion was that this agreement is simpler and easier than most, and poses no difficulties. The University of California Regents may consider the proposed lease at their January meeting, or alternatively authorize a letter of intent, in either case notifying the U.S. government that they are willing to provide the land for construction of a NMFS laboratory.

Another favorable development is that BML has survived the EIR process and long-range planning reviews, and now has the critical California Coastal Commission permit in-hand for their expansion. The approved expansion plans include the proposed NMFS laboratory. (A. MacCall, FTS 556-0565)

GROUNDFISH ANALYSIS INVESTIGATIONS

Widow Rockfish Stock Assessment Draft Prepared

Drs. William H. Lenarz and Joseph E. Hightower of the Groundfish Analysis Investigations prepared a draft of the annual stock assessment report of the widow rockfish fishery. Their assessment utilized catch at age data collected from the fishery between 1980 and 1987. Deterministic cohort analysis (computer program GENCOH) and a least squares catch at

age analysis (Computer program CAGEAN) were used to analyze the data. The two approaches gave very different results. The cohort analysis indicated that recent year classes are very strong and that the stock could support yields considerably above recent levels. The least squares results indicated that recent year classes are about average and that yields should be considerably reduced from recent levels. Because of the uncertainty in the stock status the authors recommended that 1989 yield be set at the average estimate of maximum sustained yield, 9,500 mt. The recommended yield is 21 percent below the 1988 level and slightly higher than average landings between 1983 and 1986.

The report will serve as the technical basis for the recommendation of allowable biological catch (ABC) by the Groundfish Management Team to the Pacific Management Council after review. The review process began in Menlo Park, August 8-9, when Lenarz and Hightower presented the report to the Ad Hoc Stock Assessment Committee of the team. Hightower also presented this assessment to the team later in the week. Minor revisions were made to the report because of comments by the Ad Hoc Committee. The revised report was distributed to the Team and Scientific and Statistical Committee of the Council for further review. The team will make its recommendation for ABC during the November Council meeting. (W. Lenarz, FTS 556-0565)

Preliminary Assessment of the Washington-Oregon-California Sablefish Stock

Fishery Biologists Richard Methot (Northwest and Alaska Fisheries Center) and Joseph Hightower have completed a report on the "Status of the Washington-Oregon-California sablefish stock in 1988" for the Pacific Fishery Management Council (PFMC). The report describes the use of a "stock synthesis" model, which is a general model that can incorporate information from surveys and from the fishery. The model used 1970-1987 landings data, trawl and pot survey estimates catch-per-unit-effort (CPUE), tag returns, and age and size composition data from the surveys and from 1986-1987 port sampling to estimate the current status of the stock. The model attempts to find the series of abundance estimates and fishing mortality rates that provides the best overall agreement with the sample data.

Results from sensitivity analyses indicated that conflicting information was provided by the CPUE data from the pot survey and age composition data from port sampling. The relatively sharp recent decline in pot survey CPUE was at odds with the relatively high frequency of old fish in the 1987 samples from the fishery. When the two data sources were weighted equally, estimated 1988 biomass was 79,000 mt. When pot survey CPUE data were given increased weight, estimated 1988 biomass (ages 3+) was 48,000 metric tons (mt).

Simulation results suggested that MSY was about 8,200 mt, and would be obtained at a fishing mortality rate (F) of about 0.13. This F represents the total fishing mortality for trawl and fixed gears combined, in a ratio that would maintain the current yield allocation (52% trawl). The F is for the age at which maximum combined fishing mortality would occur (which may not be the age at full recruitment to either gear); Fs for other ages would be less. The 1989 ABC (9,100 mt) was obtained by assuming a 1988 harvest of 10,800 mt and applying the estimated MSY F to the 1989 stock. Alternative estimates of ABC were produced in response to Groundfish Management Team requests for alternative approaches for reducing ABC from current levels to the estimated MSY level.

The report was reviewed at an Ad-Hoc Stock Assessment meeting and by the Groundfish Management Team August 8-12 in Menlo Park. A revised version will be presented to the Scientific Subcommittee at the PFMC meeting at Costa Mesa on September 21-22. (J. Hightower, FTS 556-0565)

GROUNDFISH COMMUNITIES INVESTIGATIONS

Strong Recruitment Continues in Several Rockfish Species Off Northern California

As predicted by the unusually early appearance of young-of-the- year (YOY) fishes during April (see Bimonthly Report for March-April), the three species that predominate in northern California's nearshore habitats - blue rockfish, *Sebastes mystinus*, yellowtail rockfish, *S. flavidus*, and black rockfish, *S. melanops* have recruited in exceptionally large numbers this year. Although assessments by the Fish Communities Investigations, led by Ted Hobson, with Fishery Biologist Tony Chess and Dan Howard, will continue for two more months, patterns are evident in data collected to date. As in previous years, there have been more YOY blues and

Table 1. Mean number YOY Sebastes spp. counted/minute at same locations on Mendocino (M) and Somoma (S) coasts.

Species		1984 M:n=57 S:n=37	1985 M:n=50 S:n=84	1986 M:n=103 S:n=60	1987 M:n=112 S:n=62	1988 M:n=76 S:n=77
S. flavidus						
	M	6.6	115.6	6.0	102.7	125.0 (14.1)[1]
	S	4.4	135.2	6.7	89.4	69.8 (8.2)
S. mystinus						
	M	1.5	70.6	7.8	181.1	101.2 (13.6)
	S	4.9	117.6	15.3	328.1	238.3 (28.2)
S. melanops						
	M	0.3	4.3	9.5	7.6	11.7 (1.2)
	S	1.6	4.4	3.0	4.5	53.6 (16.0)
Total						
	M	8.4	190.5	23.4	291.7	237.9 (21.7)
	S	10.9	257.2	25.0	442.5	361.7 (31.8)

[1]Values in parentheses for 1988 are standard errors. For standard errors, other years, see Bimonthly for November-December 1987.

blacks to the south, off the Sonoma coast, and more YOY yellowtail to the north, off the Mendocino coast (Table 1). (E. Hobson, FTS 556-0568)

PHYSIOLOGICAL ECOLOGY INVESTIGATIONS

Methods Development to Assess Condition of Young of the Year (YOY) and Juvenile Rockfishes

Biological Technician Beth Norton is currently developing methods to determine the physiological condition of YOY and later juvenile stages of rockfishes. Once these techniques become operational they will allow an assessment of the quality of recently spawned progeny which can be used to validate predictions by the Physiological Ecology Investigations of reproductive success based on a physiological evaluation of female rockfish during the previous reproductive cycle. Analyses of data generated from a 3 year study of female yellowtail rockfish *(Sebastes flavidus)* collected from Cordell Bank show several variables which appear to relate to reproductive success. However, to substantiate this relationship, measures of the health of recently spawned rockfish are needed along with estimates of year-class abundance. Measures of health or growth potential which have shown promise in investigations of early life stages of other fish species are ribonucleic acid/deoxyribonucleic acid ratios (RNA/DNA), and ratios of energy yielding lipids to structural lipids (e.g. triglycerides/phospholipids). Norton has recently completed an analysis of RNA/DNA ratios in juvenile chinook salmon reared in open water pens by the Tyee Club at the Tiburon Laboratory. The method employed was obtained from Lawrence J. Buckley (NMFS, NEFC, Narragansett Laboratory) and Frank J. Bulow (Department of Biology, Tennessee Technological University) and provided an RNA/DNA of 3.26 ± 0.37 from six specimens (Table 2). The mean weight and length of the six salmon were 22.14 ± 5.59 g and 11.8 ± 0.8 cm, respectively. The method will be used next on specimens of yellowtail rockfish juveniles provided by the Groundfish Communities and Groundfish Analysis Investigations from their recent juvenile rockfish surveys.

During the preparation of samples for nucleic acids analysis, lipids are extracted since they can be a source of interference during spectrophotometric quantification of RNA and DNA. This provides a convenient source of whole body lipids from which lipid profiles and ratios can be constructed for use in determining the nutritional status of early life stages. (B. MacFarlane, FTS 556-0565)

Table 2. Nucleic acids content of juvenile chinook salmon *(Oncorhynchus tschawytcha)*. Each nucleic acid concentration is from triplicate determinations.

Specimen number	Fresh weight (g)	Total length (cm)	RNA (mg/g)	DNA (mg/g)	RNA
1	21.91	12.0	1.55±0.09	0.45±0.02	3.44
2	17.40	11.0	1.17±0.18	0.39±0.04	3.00
3	14.63	10.7	1.40±0.14	0.48±0.06	2.92
4	26.70	12.8	1.35±0.27	0.37±0.10	3.65
5	22.54	12.0	1.32±0.16	0.46±0.08	2.87
6	29.66	12.4	1.07±0.10	0.29±0.02	3.69

Yellowtail Rockfish Fecundity

Three years of fecundity studies of yellowtail rockfish *(Sebastes flavidus)* from the Cordell Bank Seamount, approximately 26 miles northwest of San Francisco, California, have shown major differences in adult sizes and ages but no changes in fecundities. Fish steadily declined in ages, total wet weights, and standard lengths. The causes for this reduction to younger, smaller size composition of the population are unknown. If accurate, this has implications for management. Despite the differences in ages and sizes over the last 3 years, no differences were observed in age-specific, weight-specific, or length-specific fecundities (Figure 1). Results indicate that, even though age and size specific fecundities have not changed in yellowtail rockfish, the total population fecundity may have declined due to the decrease in the age/size composition of the population. Also associated with the increased numbers of younger-smaller, less fecund fish has been a reduction in the proportion of fish observed with fertilized eggs (1985-86=40.1%; 1986-87=27.7%; 1987-88=12.8%). While younger fish spawn and release young at later dates than older fish the effect of this reduction in fertilized eggs remains unclear. Abnormalities and/or malformed embryos and larvae continue to be a significant portion of the spawning of the spawning population (40%). Incidences in previous years were 55.5% and 42.5%. Sampling techniques were designed to eliminate post-mortem effects suggesting that the observed frequencies of observed malformed eggs were accurate. (M. Eldridge, FTS 556-0565)

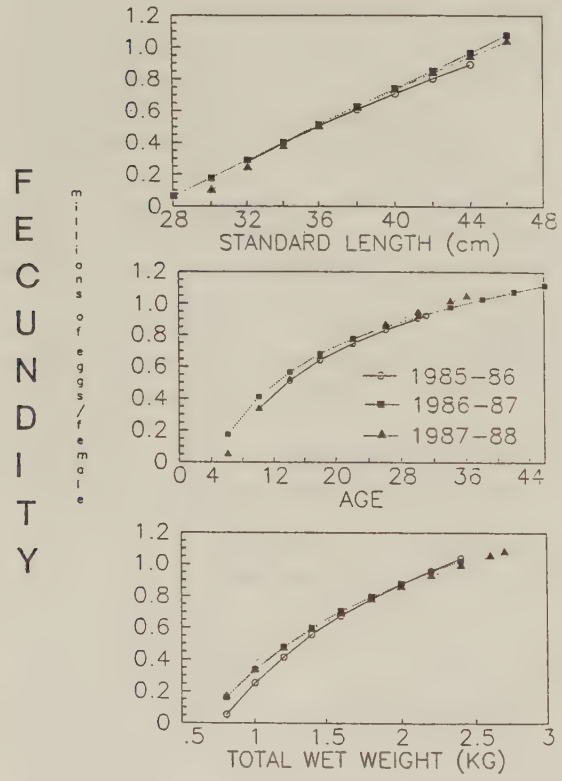

Figure 1. Fecundity of yellowtail rockfish in relation to age, total wet weight, and standard length.

INFORMATION TECHNOLOGY SERVICES

User Training Available From ITS

ITS announces the successful opening and utilization of its User Training Center at the La Jolla Laboratory. This Center is furnished with equipment supporting video and audio based courses and training workstations for hands-on exercises. The computer oriented training courses currently available are Computer Fundamen-

tals, MS/DOS, IBM/PCs, WordPerfect, DBASEIII, LOTUS 1-2- 3, and Network Communications. The Training Center is located in Room B-114. Use of the facilities can be arranged by calling ITS personnel or coming into the Training Center and signing up on the posted weekly schedule.

ITS and the Microcomputer Users' Group hosted formal introductory video classes in well-attended group settings on the fundamentals of using a PC and DOS. Since ITS owns these tapes, they are now available for individual viewing while sitting at a PC and gaining hands-on experience. There are also audio based courses for individual, self-paced training. Assistance is provided by the expertly-trained ITS staff.

This month, in accordance with the policy mandated by the Department of Commerce headquarters in Washington, D.C., ITS has rented a video based training course on measures necessary to assure computer security and avoid common breaches. This video presents a strong message concerning today's world of personal computers, modems, and centralized networks and preventing lawsuits, loss of contracts, fines, legal fees, disruption of operations, and loss of valuable data files. Because of the rental contract, the film will only be at the Center for three days and six sessions have been scheduled to accommodate all computer users' agendas. In the meantime, ITS is ever vigilant in previewing other training courses that may be helpful and pertinent to laboratory personnel, and in listening to feedback generated from the training presented. (S. Jacobson, FTS 893-7060)

STATUS OF PUBLICATIONS

Published

Alcorn, D. J., R. J. Forsyth, and R. L. Westlake. 1988. Hawaiian monk seal and green turtle research on Lisianski Island, 1984 and 1985. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-120, 22 p.

The Hawaiian monk seal, *Monachus schauinslandi*, and the green turtle, *Chelonia mydas*, at Lisianski Island were studied during 2 July-6 August 1984 and 17 June-20 July 1985, as part of ongoing research to monitor and aid the recovery of these species. In 1984, beach counts excluding pups ranged from 55 to 82 seals ($\bar{x}$ = 68.1). Fifteen weaned pups were tagged. An additional pup was found dead; six injured seals were seen. Ten tagged turtles from previous studies were resighted, seven turtles were newly tagged, and 91 turtle pits were found. Fourteen seal scats, 4 spews, and 71 lines or net debris were sampled. In 1985, beach counts excluding pups ranged from 58 to 95 seals ($\bar{x}$ = 79.1). Fourteen of the 15 pups had weaned and were tagged. Eight injured seals were seen. Eleven previously tagged turtles were resighted, 6 were newly tagged, and 78 pits were located. A total of 9 seal scats, 5 spews, and 84 lines or nets were sampled.

Boehlert, G. W., and B. C. Mundy. 1988. Roles of behavioral and physical factors in larval and juvenile fish recruitment to estuarine nursery areas, p. 51-67. In M. P. Weinstein (ed.), Transport of larval fish and shellfish through coastal inlets. Am. Fish. Soc. Symp. 3.

Recruitment to and maintenance in estuaries are important parts of the early life history of many fish species. Field studies have documented patterns of estuarine recruitment for several species; although some studies have postulated passive mechanisms for recruitment, the majority suggest specific behavior patterns that clearly correlate with physical factors or other stimuli. We consider recruitment to the estuary of species spawned offshore as a two-stage process dependent first upon factors in the offshore planktonic environment and second upon estuarine factors related to tidal flux. Rather than a simple stimulus-response mechanism related to a single physical factor, we suggest that the suite of factors associated with tidal flux at particular locations may act as the zeitgeber for an endogenous rhythm with a tidal periodicity. In this manner, an animal may use tidal-stream transport both for movement into the estuary and for maintenance within the estuary. Further work in the laboratory is necessary to elucidate these behaviors in fishes, particularly those related to endogenous rhythms and the stimuli that serve as zeitgebers.

Holt, Rennie S. and Alan Jackson. 1988. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel *McArthur*, July 30-December 10, 1987. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-116, 143 p.

Holt, Rennie S. and Stephanie N. Sexton. 1988. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel *David Starr Jordan*, August 8-December 10, 1987. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-117, 137 p.

Johanos, T. C., and S. L. Austin. 1988. Hawaiian monk seal population structure, reproduction, and survival on Laysan Island, 1985. U.S. Dep.

Commer., NOAA Tech. Memo., NOAA-TM- NMFS-SWFC-118, 38 p.

A study on the endangered Hawaiian monk seal, *Monachus schauinslandi*, on Laysan Island in the Northwestern Hawaiian Islands collected data on population structure, reproduction, and factors affecting survival (primarily adult male aggression toward adult female and immature seals) from 2 March to 30 November 1985. There were 295 individual seals identified on Laysan Island in 1985. The ratio of males to females was similar in the immature size classes but was nearly 2:1 in the adult size class. Excluding pups, a net increase of 25 identified individuals occurred between the 1984 and 1985 field seasons. At least 32 pups were born, 18 males and 14 females. Average nursing period was 40 d (range, 32-45 d). One exchange of pups between nursing females was observed. At least 59% of the adult females identified on Laysan Island pupped in 1985. The average length of time between births in successive years was 379 d (range, 361-408 d). At least 40 injuries were sustained by 37 individual seals, and 7 seals died (2 adult females, 2 subadult males, and 3 male pups). Fourteen of the injuries and five of the deaths were caused by adult male aggression. This paper describes a birth, four adult male mobbings, two similar acts of aggression by single males, and a shark attack.

Squires, Dale. 1988. Production technology, costs, and multiproduct industry structure: an application of the long-run profit function to the New England fishing industry. Can. J. Econ. 21(2):359-378.

The long-run multiproduct profit function is developed to provide a more general procedure than the static minimum cost function to examine the technological and cost determinants of multiproduct industry structure and the likely form of any market equilibrium. In this approach outputs are endogenous and the long-run equilibrium levels of quasi-fixed factors are endogenously determined. The multiproduct structure of the multispecies New England fishing industry and the likely multiproduct form of any open-access equilibrium are examined.

Squire, James L. 1987. Pacific billfish angler catch rates for key area stock assessments. Mar. Fish. Rev. 49(2):15- 25.

The Pacific Billfish Angler Survey was initiated in 1969 to measure the trend of angler CPUE annually. Survey respondents (1969-84) have reported 145,661 angler days catching 59,460 billfish, resulting in an average CPUE of 0.41 fish/day or 2.45 days of fishing per billfish. Annual totals of catch, effort, and resulting CPUE are given for many of the important recreational billfish fishing areas. A comparison of CPUE trends between the commercial longline and the recreational angler is made for the area about the southern tip of Baja California where high CPUE rates are common to both fisheries. The correlation between recreational and commercial CPUE is reasonable ($Y_2 = 0.82$), and the recreational angler CPUE is negatively affected by the nearby commercial longline fishery.

Squire, James L. 1987. Relation of sea surface temperature changes during the 1983 El Niño to the geographical distribution of some important recreational pelagic species and their catch temperature parameters. Mar. Fish. Rev. 49(2):44-57.

Squire, James L. 1987. Striped marlin, *Tetrapturus audax*, migration patterns and rates in the northeast Pacific Ocean as determined by a coopaerative tagging program: its relation to resource management. Mar. Fish. Rev. 49(2):26- 43.

Migration patterns and rates for striped marlin, *Tetrapturus audax*, tagged and recaptured in the northeast Pacific Ocean during 1957-81 are reported by time period and analyzed. Few long-range migrations and no trans-Pacific migrations were observed. Comparisons are made with other types of physical and biological data that might indicate seasonal movement (i.e., longline catch rates, areas of striped marlin spawning, movement of thermocline depth relative to fishing success). A tentative hypothesis describing the seasonal movment of striped marlin in the northeast Pacific and the total eastern Pacific is also proposed and presented in graphic form.

Westlake, R. L., and P. J. Siepmann. 1988. Hawaiian monk seal and green turtle research on Lisianski Island, 1986. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-119, 18 p.

The endangered Hawaiian monk seal, *Monachus schauinslandi*, and the threatened green turtle, Chelonia mydas, were studied intermittently on Lisianski Island throughout the summer in 1986. Field personnel were present on three occasions: 3 May, 30 May-2 June, and 5-26 August 1986. A total of 10 censuses were conducted; seal beach counts ranged from 76 to 107 (excluding pups), with a mean of 94. Twenty live pups were tagged after weaning, and two pup carcasses were found. Two adult female seals were seen with fresh dorsal wounds, and up to six adult and subadult females were seen with older, healing dorsal wounds. Eight green turtles were identified by tags: five were tag resightings from previous years and three were newly tagged in 1986. An adult green turtle was found dead, and 15 individual turtle nest sites were located. A total of 174 net and debris items capable of entangling seals and turtles were inventoried and destroyed. Two seals were found entangled in debris and were immediately released.

White, Francis C., Ray Kelly, Scott Kemper, Paul T. Schumacker, Kim R. Gallagher, and R. Michael Laurs. 1988. Organ blood flow haemodynamics and metabolism of the albacore tuna *Thunnus alalunga* (Bonnaterre). Exp. Biol. 47:161-169.

Metabolic haemodynamic, and organ blood flow measurements were made in tabled, partially anaesthetized albacore *Thunnus alalunga*. Heart rates were 115 ± 9 beats/min: blood pressure 98/75 mm Hg (systolic/diastolic): cardiac output 36.1 ± 5 (ml/;min/kg): oxygen consumption 3.4 ± 0.7 (ml O_2/min/kg) and cardiac contractility dP/dt) 6342 ± 822 mm Hg/s. Organ blood flows were measured with radiolabelled microspheres. The red muscle, kidney, and spleen received the highest flows and the white-muscle the least. There was a flow gradient in the white-muscle with the inner portion near the red-muscle receiving the highest flows. Arterial and venous blood gas measurements showed a reverse temperature effect on arterial PO_2 and a P_{50} of 15.9 Torr corrected to 37°C. Red-muscle temperature was 7°C higher than ambient water temperature. These measurements record the albacore's markedly high cardiovascular capability.

Approved, Science and Research Director, SWR

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